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CONTENTS
Vol. 30

No. 1
Published 7th November, 1975

No. 2
Published 12th November, 1975

No. 3
Published 13th October, 1975

No. 4

Published 20th November, 1975

No. 5

Published 16th January, 1976

No. 6

Published 16th January, 1976

No. 7

Published 16th January, 1976

No. 8

Published 16th January, 1976

No. 9

Published 16th January, 1976

No. 10

Published 30th June, 1976

No. 11

Published 30th June, 1976

No. 12-14

No. 15

No. 16-19

A REVISION OF AUSTRALIAN CANCELLARIIDAE (GASTROPODA: MOLLUSCA)

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SUMMARY

A description is given and comparisons made, with both Recent and some Tertiary fossil species, of all known Recent species in the family Cancellariidae from Australian waters. Two species (1 new subsp., *Cancellaria* (*Merica*) *melanostoma westralis*) are included in *Cancellaria* (*Merica*), 1 in *C.* (*Nevia*), 8 (1 new, *Cancellaria* (*Sydaphera*) *panamuna*) in *C.* (*Sydaphera*), 3 (1 new, *Fusiaphera dampierensis*) in *Fusiaphera*, 13 (3 new, *Trigonostoma diamantina*, *Trigonostoma iota* and *Trigonostoma tessella*) in *Trigonostoma*, 1 in *Admetula*, 3 (1 new, *Gergovia haswelli*) in *Gergovia*, 3 (1 new, *Inglisella nympha*) in *Inglisella*, 2 in *Pepta*, 1 in *Vercomaris* (new), 1 in *Bonellitia*, and 1 (new, *Zeadmete kulanda*) in *Zeadmete*.

INTRODUCTION

Order NEOGASTROPODA

The origin and evolution of the Neogastropoda has been well covered by Ponder (1973), who assigns to the superfamily Cancellariacea (Synonym Nematoglossa Olsson, 1970) the families Cancellariidae and Paladmetidae, an extinct group lacking columella folds.

Family CANCELLARIIDAE

The family Cancellariidae falls within the order Neogastropoda in most respects, the main anatomical difference being in the radula, which as Olsson (1970) states is unique, and differs fundamentally from those of other named taxa. The cancellariids have a single row of elongated blade-like teeth (Barnard, 1958: Graham, 1966) each an aggregate of "rectangular tubes which form a canal system which transverses the whole length of the radular filaments" (Olsson, 1970).

It is not known how the Cancellariidae feed, although Olsson suggests that they may feed on micro-organisms, these being transported down the minute tubes that make up each tooth.

All species possess columella plaits in common with several other families included in the order, except some classified by Cossmann (1899) in a subfamily Admetinae. Most of these are from deep to very deep water, lacking in colour, and devoid of plaits or showing only one or two vestigial remains.

Records of the Australian Museum, 1975, 30, 1–62, figures 1–5

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As many species exist on submerged rocky or coral reefs, few are brought up alive by dredging, even at night. It has therefore proved difficult to find long series of first-class specimens for study in many cases, even in extensive Museum collections. This revision has been compiled for the purpose of placing on record, by descriptions and illustrations, all species so far known to live in Australian waters and is not a complete revision of the family; the collections of all State Museums have been studied.

Taxonomic references have been confined to the original authors, those containing references to illustrations, and also any references by Australian authors. Brief diagnostic features are described under each genus.

FOSSIL SPECIES

A list of southern Australian Tertiary fossils with a few brief particulars is included towards the end of this revision for reference purposes. Descriptions and illustrations have been omitted as they are the subject of study at the present time by Mr Thomas A. Darragh, Deputy Director of the National Museum of Victoria, for later publication.

ORDER OF PRINTING

The type for each genus is printed first if it occurs in Australian waters, otherwise all are in alphabetical order. An index to species is at rear of the revision. Genera are dealt with in the order shown below.

SUMMARY OF GENERA AND SUBGENERA

dealt with in this revision

Cancellaria (*Merica*) H. and A. Adams, 1854.

(*Nevia*) Jousseaume, 1887.

(*Sydaphera*) Iredale, 1929.

Fusiaphera Habe, 1961.

Admetula Cossmann, 1889.

Trigonostoma Blainville, 1827.

Bonellitia Jousseaume, 1887.

Gergovia Cossmann, 1899.

Inglisella Finlay, 1924.

Pepta Iredale, 1925.

Vercomaris Garrard, nov.

Zeadmete Finlay, 1927.

ABBREVIATIONS USED

A.M.	Australian Museum, Sydney, New South Wales.
B.M.N.H.	British Museum (Natural History) London, England.
N.M.V.	National Museum of Victoria, Melbourne, Victoria.
Q.M.	Queensland Museum, Brisbane, Queensland.
Q.V.M.	Queen Victoria Museum, Launceston, Tasmania.
S.A.M.	South Australian Museum, Adelaide, South Australia.
T.M.	Tasmanian Museum, Hobart, Tasmania.
W.A.M.	Western Australian Museum, Perth, Western Australia.

SYSTEMATIC SECTION

Genus *CANCELLARIA* Lamarck, 1799

Type species by original designation *Cancellaria reticulata* Linnaeus

Subgenus *Merica* H. and A. Adams, 1854: 277. Type species by subsequent designation (Cossmann, 1899: 13) *Cancellaria* (*Merica*) *melanostoma* Sowerby, 1848.

References: Adams, H. and A., 1854: 277; Chenu, J. C., 1859: 277; Jousseaume, F., 1887: 29; Cossmann, M., 1899: 13; Tryon, G. W. 1885: 65; Schepman, M. M., 1911: 263; Kuroda, Habe and Oyama, 1971: 309.

Synonyms: *Contortia* Sacco, 1894. (Wenz, 1938–44: 1357). *Momoebora* Kuroda, Habe and Oyama, 1971. Type species *Cancellaria* (*Momoebora*) *sinensis* Reeve. (Deviated protoconch is only difference).

Diagnosis: Large, heavy and solid, ovate, whorls decussated, aperture widely oblong, inner-lip calloused, outer-lip acute, lirate internally, columella straight with 3 oblique plaits; differs from *Cancellaria* s.s. by cancellate in place of reticulate sculpture, and columella plaits are decidedly smaller than the gross plaits of *Cancellaria reticulata* Linnaeus.

Cancellaria (*Merica*) *elegans*, Sowerby, 1822

Figure 1 (1)

Cancellaria elegans Sowerby, 1822, pl. 218, fig. 3; Sowerby, 1849: 446, pl. 93, fig. 36, pl. 96, fig. 104; Reeve, 1856, pl. 3, fig. 12.

Cancellaria reeveana Crosse, 1861: 237 (new name for *C. elegans* Sowerby, non Deshayes, 1824. Invalid name change); Loebbecke, 1885: 12, pl. 2, figs 1, 2, 4–6.

Merica reeveana; Kira, 1962: 91, pl. 32, fig. 21.

Description: Protoconch $1\frac{1}{2}$ to 2 smooth, shining, slightly deviated whorls, merging gradually into main whorls, nucleus submerged. *Teleoconch* 5 convex whorls, roundly shouldered, slightly constricted at base. *Sutures* deeply impressed at base of shallow canal. *Sculpture* of fine, sharp, oblique ribs, up to 32 on body-whorl and 22 on penultimate, crossed by fine sharp transverse striae, 15 on body-whorl and 5 on penultimate; between these striae are from 4 to 7 fine threads, central the strongest, finely granulated by intersecting microscopic growth lines; between main striation on top of shoulder and suture are 5 to 8 microscopic striae. *Umbilicus* a fine narrow aperture behind inner-lip callus. *Aperture* widely elongate, contracted either end, a short narrow open siphonal canal; columella arched towards outer-lip anteriorly, one strong plait in centre, slightly oblique, posterior plait weaker and more oblique, a third fold at anterior end forms edge of canal; inner-lip strongly calloused on to body-whorl and over umbilical opening, granulose anteriorly; outer-lip thick but sharply edged, crenulate, depressed inwards posteriorly, flared outwards anteriorly, 10–12 strong lirae extend well into aperature. *Colour* off-white, with 3 broad light or dark brown bands on body-whorl, 2 on penultimate, leaving 2 narrow white bands between; aperture inside outer-lip, also base of inner-lip, frequently marked with similar brown.

Type locality. None given.

Dimensions. Holotype unknown. Average size, length 32 mm, breadth 18 mm. Largest specimen examined, length 35 mm, breadth 23 mm.

Location of type. B.M.N.H. Not located at present.

Distribution. From Sweers Island, Gulf of Carpentaria (17° 05′ S., 139° 37′ E.), round Cape York Peninsula, southwards along Queensland coast to Toogoom Beach, north of Hervey Bay, Queensland (25° 10′ S., 152° 35′ E.) Subtidal down to 49 metres.

Material. Sweers Island as above, 1 specimen, A.M. No. C. 75249. Toogoom Beach as above, 1 specimen, A.M. No. C. 89754. Greatest depth as above, 49 metres off Island Head, 91 km N. of Yeppoon, Q. (22° 38′ S., 160° 20′ E.), 4 specimens ex T. A. Garrard coll., A.M. No. C. 89756. A.M. 57 specimens (19 lots), N.M.V. 28 specimens (11 lots), others from Q.M., S.A.M. and W.A.M. Total 95 specimens (36 lots), all throughout the above range.

Discussion. Sherborn (1894: 370–1) shows the date of parts 1–9 of the *Genera of Recent and Fossil Shells* to have been issued in 1822, the part covering Cancellariidae being No. 5. (The Index in B.M.N.H. has pencilled 1821 for part 5, also a further note in front mentioning 1821, these notes being Sherborn's). Sykes (1906: 191) gives date of part 1 as 31/12/1821, parts 3–13 as various dates in 1822, part 5 being 30/4/1822. As both Sherborn and Sykes published the date 1822 this has been adopted.

The holotype at B.M.N.H., used for Sowerby's illustration, was "a specimen in Mrs Mawe's collection", but is unable to be located at present. Queensland specimens have been checked with an enlarged photograph of a specimen from an old lot in B.M.N.H., with "*Cancellaria elegans*" printed on the back of a board to which they are glued, but there is no evidence to show that these specimens were Sowerby's. Queensland specimens agree perfectly with this photograph, and in turn match Sowerby's original figure as closely as it is possible to determine.

Deshayes (1843: 402) referred *Cancellaria elegans* to his *Cancellaria asperella*, not stating whether he was aware that the name *C. elegans* was supposedly pre-occupied, but Reeve stated (1856: pl. 3, sp. 12) that "This fine species (*C. elegans*)

differs from *C. asperella*, to which M. Deshayes refers it, in being of a more fusiform growth . . . and not being excavately channeled at the suture." The name *C. elegans* was then replaced unnecessarily in 1861 by Crosse with his new name *Cancellaria reeveana*. In spite of this confusion, and whether or not the species known as *C. asperella* Deshayes later proves to be synonymous with *C. elegans*, this need not concern us so far as Australian species are concerned, the identity of the Queensland species as *C. elegans* having been established with very little doubt.

Apart from the coarser axial ribbing in this species compared with *Cancellaria* (*Merica*) *melanostoma westralis* nov., the allied species occurring in Western Australia, *C.* (*M.*) *elegans* also has 4–7 fine threads between the main transverse striae, whereas *C.* (*M.*) *melanostoma westralis* has only 3, central the strongest, in all specimens examined.

Cancellaria (*Merica*) *melanostoma westralis* subsp. nov.

Figure 1 (2) and (3)

Description: Protoconch 2½ smooth, shining whorls, merging gradually into main whorls, nucleus submerged. *Teleoconch* 4 roundly convex whorls, first whorls roundly shouldered but vertical at base. *Sutures* deeply impressed at base of narrow canal. *Sculpture* of numerous fine oblique axial riblets, about 65 on body-whorl, 40–45 on penultimate, crossed by numerous transverse striae of equal strength, with fine threads between; whole sculpture has a granulated appearance and is over-ridden by microscopic growth lines. *Umbilicus* a fine fissure behind inner-lip callus. *Aperture* widely elongate, contracted either end, short wide open siphonal canal; columella straight with 3 strong oblique plaits, inner-lip reflected as strong callus on to body-whorl; outer-lip regularly curved, flared outwards anteriorly, sharply edged and finely crenulated; about 16 lirations commence near edge of outer lip and extend well into aperature. *Colour* frequently pure white, but often with brown bands of irregular width and depth of colour, some very dark with no white remaining; aperture white or cream, anterior end of columella very dark in some of the darker specimens.

Type locality. Turtle Bay, North-West Cape, Western Australia (22° 20′ S., 114° 09′ E.).

Dimensions. Holotype, length 30·2 mm, breadth 19·8 mm—average size. Coll. L. Figgis, Feb., 1972. Largest specimen examined, 35 mm x 23 mm.

Location of type. Presented to W.A.M., Perth, W. Aust. Reg'd No. 697-44 Ex. A.M., Sydney.

Distribution. Type locality as above, and Bay of Rest, Exmouth Gulf, W. Aust. (22° 18′ S., 114° 07′ E.), to Yampi Sound, N.W. Aust. (16° 07′ S., 123° 35′ E.), eastwards to Darwin, Northern Territory (12° 25′ S., 130° 50′ E.). Appears to be subtidal only.

Material. Bay of Rest as above, 1 specimen, "Ningaloo" Exped., 27/8/68, W.A.M. No. 485-71. Yampi Sound as above, 1 specimen, W.A.M. No. 487-71. Darwin as above, 1 specimen, Q.M. unreg'd. A.M. 48 specimens (18 lots), N.M.V. 23 specimens (11 lots), S.A.M. 10 specimens (2 lots), W.A.M. 9 specimens (7 lots), Q.M. 1 specimen. Total 91 specimens (39 lots).

In addition 9 specimens are held by S.A.M. marked as below:

2 white specimens marked Hong-Kong, S.A.M. No. D. 15122.

3 with red-brown bands marked China, No. D. 7506.

4 with red-brown bands marked Philippines, No. D. 15121.

2 further specimens marked Hong-Kong, pres. C. Hedley, held by A.M., Reg'd No. C. 36767.

As 2 of these 4 lots were purchased from shell dealers as shown on the labels, the probability exists that the others were also, and marked with a published or known locality where the species occurs, it being common practice to do this where the actual source of a specimen is unknown. The strong resemblance to *C.* (*Merica*) *sinensis* Reeve would suggest to the dealers the localities marked, and as no definite evidence can be obtained in confirmation, this new subsp. possibly exists only in the distribution area as shown above.

Discussion. This species has been named as new only after comparison with a number of specimens, also with enlarged photographs of holotypes, of *C.* (*Merica*) *sinensis* Reeve, and *C.* (*M.*) *melanostoma* Sowerby (2 specimens are figured at pl. 4, figs 15, 16); the canaliculate whorls and distinctive finely cancellate sculpture set it apart from others without difficulty. The closest species in general appearance is *C.* (*Merica*) *sinensis* Reeve from Japan, which is without the canal at the suture and has an acutely deviated protoconch. Richard E. Petit states (pers. comm.) that he has examined many hundreds of specimens of *C.* (*M.*) *sinensis* from Japan and further south, and that without exception all had the deviated form of protoconch, also that the species occurs from southern Taiwan northwards. Comparison has been made with photographs of the holotype of *C.* (*M.*) *melanostoma* Sowerby, the type for the subgenus, also with photographs of Reeve's and Sowerby's figured specimens (pl. 4, figs 15, 16 as above), and they show this subspecies to be closely related, the main point of similarity being the almost identical sculpture. This new subspecies differs consistently however in the following respects:

1. Canal at top of shoulder is decidedly deeper.
2. The columella plaits are decidedly less prominent and less oblique.
3. The parietal shield does not extend entirely over the umbilical area, but leaves a small fissure exposed.
4. The outer-lip is more depressed inwards posteriorly and flared outwards anteriorly.
5. Colour patch on anterior end of parietal shield is consistently lighter in colour.

From information available *C.* (*M.*) *melanostoma* is confined to the Persian Gulf area.

Subgenus *NEVIA* Jousseaume, 1887: 222. Type species by original designation *Cancellaria spirata* Lamarck, 1822

References: Nil.

Diagnosis: Shell medium, solid, ovate, deeply canaliculate, aperture widely oblong, tapering either end; outer-lip acute, lirate internally; columella straight

with 3 oblique plaits; axially ribbed in early whorls, ribs tending later to flatten or disappear. Deep canal at top of shoulder is main distinguishing feature.

Cancellaria (*Nevia*) *spirata* Lamarck, 1822
Figure 1, (4) and (5)

Cancellaria spirata Lamarck, 1822: 115.—Sowerby, 1832: 4, fig. 25.—Deshayes, 1839: 645.—Kiener, 1841: 38, pl. 4, fig. 3.—Deshayes, 1843: 408.—Sowerby, 1849: 449, pl. 93, fig. 22.—Reeve, 1855: 10, pl. 12, fig. 56.—Chenu, 1859: 276, fig. 1833.—Loebbecke, 1885: 25, pl. 6, figs 9, 10.—Cotton and Godfrey, 1932: 55, pl. 3, fig. 4.

Cancellaria (*Trigonostoma*) *spirata* Tryon, 1885: 77, pl. 4, fig. 71, pl. 5, fig. 72.

Cancellaria excavata Sowerby, 1848: 137.—Sowerby, 1849: 449, pl. 93, fig. 18.—Crosse, 1861: 234.—Loebbecke, 1885: 92, text figs.

Description: Protoconch 2 smooth, shining, deviated whorls, merging gradually into main whorls, nucleus well submerged. *Teleoconch* 4 flatly convex whorls, turreted, deeply canaliculate. *Sutures* well impressed. *Sculpture* of numerous deeply-incised transverse lines with finer lines between, body-whorl may have over 100 on good specimens; narrow, close-set rounded axial riblets on first 2 or 3 whorls in most specimens, becoming irregular folds later and tending to disappear on body-whorl; whole sculpture crossed by fine growth lines. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* broadly ovate, contracted either end, a short narrow open siphonal canal; columella straight, 3 strong oblique plaits, anterior plait continues to end of canal; peritreme entire, inner-lip reflected and strongly calloused over umbilical fissure; outer-lip regularly curved, reflected outwards anteriorly, sharp-edged, 12 strong lirations extending well into aperture. *Colour* cream with band of dark brown square blotches below suture and one or two indefinite bands below; some specimens with vertical markings below sutures continued as axial flames down body-whorl; interior white with irregular traces of brown in some specimens.

Type locality. Garden Island, Swan River, Western Australia (32° 02′ S., 115° 47′ E.).

Dimensions. Holotype, length 19·125 mm. Grows to 35 mm length, 22 mm breadth. Average size 28 mm x 18 mm.

Location of type. Two syntypes Museum d'Histoire Naturelle, Geneva, Reg'd No. 1097/90.

Distribution. From Bunbury, Western Australia (33° 25′ S., 116° 03′ E.) southwards and along southern Australian coastline to Western Port Bay, Victoria (38° 20′ S., 145° 40′ E.), and including Tasmania, exact localities not marked. Intertidal and subtidal.

Material. Bunbury as above, 1 specimen, W.A.M. No. 364-40. Western Port Bay as above, 8 specimens, A.M. No. C. 74980.

A.M. 120 specimens (26 lots), N.M.V. 78 specimens (19 lots), W.A.M. 60 specimens (17 lots), S.A.M. 39 specimens (14 lots), Q.M. 10 specimens (1 lot). Total 307 specimens (77 lots).

Discussion. This species is variable in length-width ratio, strength of columella plaits, and presence or otherwise of axial ribs. It closely resembles *C.* (*Sydaphera*)

lactea Deshayes, but the canaliculate whorls of *C.* (*Nevia*) *spirata* distinguish it. Western Australian specimens generally grow to a larger size, are more prominently sculptured and with bolder markings. The species has a superficial resemblance to *Zemira australis* (Sowerby), family Olividae, with which it appears to be often confused by collectors, but the latter has no plaits, no canal at the shoulders, and a sharp tooth towards the anterior end of the outer lip.

Subgenus *Sydaphera* Iredale, 1929: 341. Type species by original designation *Sydaphera renovata* Iredale (= *Sydaphera undulata* Sowerby, 1848).

References: Kuroda, Habe and Oyama, 1971: 310; Wenz, 1938–44: 1367.

Diagnosis: Large to very large, heavy and solid, spire medium or exserted, whorls shouldered, strongly axially ribbed and cancellate, aperture ovate, lirate internally, columella straight and 3-plaited; protoconch 1½ tall prominent whorls, first half-whorl deviated. Compared with *Cancellaria reticulata* Linnaeus, the type for genus *Cancellaria* s.s., *Sydaphera* species consistently have three medium-sized plaits compared with two in *C. reticulata*, of which the posterior is very large and prominent with one or two smaller ridges; *C. reticulata* also has a regular two whorled protoconch with no sign of deviation as in *C.* (*Sydaphera*). Tertiary fossil species are *Cancellaria wannonensis* Tate and *Cancellaria torquayensis* Chapman.

Note: The only feature which distinguishes the genus *Cancellaria* (*Nevia*) Jousseaume from *C.* (*Sydaphera*) Iredale is the deep canal at the shoulder. However if the two were to be regarded as congeneric *C.* (*Nevia*) would take precedence. As no species now included in *C.* (*Sydaphera*) is canaliculate it is advisable to regard them as separate subgenera.

Cancellaria (*Sydaphera*) *undulata* Sowerby, 1848

Figure 1, (6) and (7), figure 5, (1), (2) and (3)

Cancellaria undulata Sowerby, 1848: 136; 1849: 443, pl. 92, fig. 12; pl. 95, fig. 79.—Reeve, 1856, pl. 3, fig. 9.—Angas, 1865: 171, no 93.—Loebbecke, 1885: 40, pl. 13, figs 1–3.—Tryon, 1885: 67, not fig'd.—Watson, 1886: 273.—Hedley, 1913: 304.—Cotton and Godfrey, 1932: 54, pl. 3, fig. 2.

Sydaphera undulata.—Macpherson and Gabriel, 1962: 226, fig. 269.

Sydaphera renovata Iredale, 1929: 341, pl. 38, fig. 3; Iredale, 1931: 231, pl. 23, fig. 7; Laseron, 1955: 267, figs 1, 2.

Sydaphera obnixa Iredale, 1936: 318, pl. 23, fig. 6; Laseron, 1955: 269, fig. 3.

Sydaphera deliciosa Laseron, 1955: 269, fig. 5.

Description: Protoconch 2 prominent whorls, first half-whorl deviated, smooth and shining, nucleus submerged. *Teleoconch* up to 6 whorls, flatly convex, roundly shouldered, almost vertical at base. *Sutures* slightly impressed. *Sculpture* commences with fine axial ribbing on early whorls, ribs becoming more prominent as growth advances, also tending to become irregularly spaced on many specimens and often mere undulations on body-whorl; initial transverse sculpture of finely incised lines through ribs and interstices, increasing in number, becoming broader and shallower, and more irregular in width of spacing; number of ribs on body-whorl and penultimate varies from 12 to 22, and number of depressed lines on body-whorl from 35 to 45, the interspaces frequently becoming raised into flatly rounded cords; whole sculpture is crossed by microscopic growth lines, giving impression of pitting

in the depressed lines. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* elongate, recurved anteriorly below columella in form of a short open siphonal canal; columella straight, two strong slightly oblique plaits, with third anterior fold forming edge of canal; inner-lip recurved as strong glazed callus over umbilical fissure, coarsely granulose anteriorly; outer-lip regularly curved, sharply edged, flared outwards anteriorly; 14 to 18 lirations commence below edge of outer-lip and extend well into aperture. *Colour*—base colour cream, irregularly banded with fawn or light brown and white, the white being on some, but not all, of the flatly raised cords; a band of irregular dark-brown blotches on the shoulders; aperture irregularly coloured with fawn or brown blotches or bands.

Type locality. Port Jackson, New South Wales (Brazier, 1884: 226). (33° 57′ S., 151° 09′ E.).

Dimensions. Holotype, length and breadth not given. An average specimen measures approx. 43 mm length, 26 mm breadth; maximum approx. 60 mm length, 37 mm breadth.

Location of type. B.M.N.H. Reg'd No. 1968266.

Distribution. From Toogoom Beach, Hervey Bay, southern Queensland (25° 12′ S., 152° 22′ E.) southwards along Queensland coast, throughout New South Wales, Victoria, Tasmania, South Australia, southern coast of Western Australia and northwards to Dunsborough (33° 41′ S., 115° E.), and N.E. of Rottnest Island (32° 03′ S., 115° 32′ E.), 31 metres, lowest depth recorded. Average depth approx. 5 metres.

Material. Toogoom Beach as above, 1 specimen, A.M. No. C. 89746, Dunsborough as above, 1 specimen, coll. B. R. Wilson, 12/1955, W.A.M. No. N/2050; Rottnest Island as above, 1 specimen, F.V. "Bluefin", 18/9/65, W.A.M. No. 499-71.

A.M. 415 specimens (97 lots), N.M.V. 286 specimens, (59 lots), S.A.M. 101 specimens (16 lots), Q.M. 53 specimens (9 lots), W.A.M. 21 specimens (5 lots), total 876 specimens (186 lots).

Discussion. This species is by far the most common in Australian waters and has the widest distribution. One specimen from the Hargreaves collection is held by A.M. (No. C. 38855) marked "New Caledonia", and a further specimen from a private collection, a typical *C.* (*Sydaphera*) *undulata*, is also marked as being from same locality. If these localities are correct it would appear almost certain to be the species named as *Cancellaria semperiana* Crosse, which would be synonymous with *C.* (*S.*) *undulata*. However definite proof from New Caledonia has proved impossible to obtain, although an enlarged colour photograph of the type of *C. semperiana* certainly appears to confirm this.

A comparison of the holotype of *Sydaphera deliciosa* Laseron, (A.M. No. C. 80102) type locality Woolgoolga, N.S.W., with many specimens from the surrounding area, shows it to be a weakly ribbed, immature and worn specimen of *C.* (*S.*) *undulata*, several intermediate specimens being observed. Similarly *C.* (*S.*) *renovata* Iredale (A.M. No. C. 57838) and *C.* (*S.*) *obnixa* Iredale (A.M. No. C. 60664) both fall well within the range of variation exhibited by series of specimens from many parts of the area of distribution of *C.* (*S.*) *undulata*.

Cancellaria (*Sydaphera*) *anxifer* Iredale, 1925

Figure 1, (9) and (10)

Cancellaria purpuriformis anxifer Iredale, 1925: 264, pl. 43, fig. 24.

Sydaphera anxifer; Laseron, 1955: 269, fig. 6.

Description: Protoconch 1½ smooth shining whorls, first half-whorl deviated, merging gradually into main whorls, nucleus submerged. *Teleoconch* 4½ rounded convex whorls. *Sutures* deeply impressed. *Sculpture* of fine oblique axial ribs, 14 on both body-whorl and penultimate, crossed by flat-topped transverse cords of indefinite outline, 10–12 on body-whorl, 4–5 on penultimate, with numerous flat-topped minor cords and threads between; whole sculpture crossed by microscopic growth lines. *Umbilicus* absent. *Aperture* ovate, narrowing anteriorly to a short open siphonal canal; columella straight with 3 strong oblique plaits; inner-lip reflected as light callus over body-whorl; outer-lip regularly curved, thin and sharp-edged; about 12 lirations commence close to edge and extend well into aperture. *Colour* pale fawn with brown bands, lighter band above sutures continues round centre of body-whorl, dark brown spots on top of shoulders.

Type locality. Off Eden, New South Wales (37° 05′ S., 150° 07′ E.), 45–54 metres.

Dimensions. Holotype, length 23 mm, breadth 12 mm. Normal size. Largest specimen examined 28 mm length, 15 mm breadth.

Location of type. A.M., Sydney, Reg'd No. C. 53773.

Distribution. 5 km E. of Forster, N.S.W. (32° 15′ S., 152° 30′ E.), to E. of Twofold Bay, N.S.W. (37° 05′ S., 149° 45′ E.). Greatest depth, 146 metres off Sydney, N.S.W. (34° 03′ S., 151° 15′ E.). One authentic specimen from Stanley, N.W. Tasmania, very pale in colour, a little broader for length than N.S.W. specimens, otherwise identical. Coll. Sir Henry Somerset, T.M. Reg'd No. E. 6695. Shallow to medium depths.

Material. E. of Forster as above, 11 metres, 1 specimen ex. T. A. Garrard coll., A.M. No. C. 90180. Off Twofold Bay as above, 82 metres, 3 specimens, ex. T. A. Garrard coll., A.M. No. C. 90085. Greatest depth as above, 146 metres off Sydney, ex. T. A. Garrard coll., A.M. No. C. 90075.

A.M. 32 specimens (16 lots), N.M.V. 4 specimens (3 lots), W.A.M. 1 specimen, T.M. 1 specimen. Total 38 specimens (21 lots).

Discussion. This species was originally named by Iredale (1925: 264), as a subsp. of *Cancellaria* (*Sydaphera*) *purpuriformis* Valenciennes, from which it differs considerably by its cancellate sculpture of fine axial ribs overridden by transverse cords, compared with the numerous fine transverse grooves of *C.* (*S.*) *purpuriformis*. It is usually only obtainable by dredging.

Cancellaria (*Sydaphera*) *australis* Sowerby, 1832

Figure 2, (1) and (2)

Cancellaria australis Sowerby, 1832: 3, fig. 23; 1849: 442, pl. 95, figs 72, 73.—Brazier, 1877: 311.—Hedley, 1913: 304.—Reeve, 1856; pl. 10, fig. 24.—Tryon, 1885: 69, pl. 2, fig. 22.—Crosse, 1861: 236.—Loebbecke, 1885: 83, pl. 21, fig. 6.

Description: Protoconch 1½ whorls, smooth and shining, first half-whorl deviated, merging gradually into main sculpture, nucleus submerged. *Teleoconch*

4 convex whorls, body-whorl 75 per cent of total length. *Sutures* deeply impressed. *Sculpture* of slightly oblique rounded axial ribs, about 25 on body-whorl and 22 on penultimate, crossed by strong transverse striae, about 14 on body-whorl and 6 on penultimate, forming elongate nodules at intersections; 2 or 3 fine threads between transverse striae, the whole crossed by microscopic growth lines. *Umbilicus* a fine fissure behind inner-lip callus, axial ribs continued into opening. *Aperture* oval, half-length of shell; outer-lip regularly curved, sharp-edged, flared outwards anteriorly, 12 strong lirations within; columella straight, 3 strong plaits, posterior slightly oblique, central and anterior strongly so, anterior forming edge of a short wide-open siphonal canal; inner-lip reflected as heavy glaze on to body-whorl. *Colour* shining white.

Type locality. New South Wales. No specimen is since on record from New South Wales, but as Queensland formed part of "New South Wales" when the species was recorded it is quite possible that the species was taken in Queensland waters. It is not on record from elsewhere as far as known.

Dimensions. Holotype, length 20·25 mm, breadth 12·66 mm. Largest of 3 paratypes, length 21·8 mm, breadth 13 mm.

Location of type. B.M.N.H. Reg'd No. 1968388.

Distribution. Type locality only.

Material. Four specimens as above at B.M.N.H. The specimen recorded by Brazier (1877: 311) from 54 metres off Darnley Island, Torres Strait, is held in the Macleay Museum, University of Sydney, unregistered. On examination this has proved to be the body-whorl only of *Fusiaphera dampierensis* nov. (this revision).

Discussion. Description of this species has been compiled from the original description coupled with examination of enlarged photographs of two of the four syntypes by courtesy of B.M.N.H. The only mention of this species during the present century appears to be that by Hedley (1913: 304), who provisionally identified a species from Port Curtis, Queensland. This was most likely the species, later named by Iredale as *Cancellaphera amasia* (1930: 80), the type locality being Port Curtis; this occurs quite frequently in a pure white form which bears a superficial resemblance to *C.* (*Sydaphera*) *australis*, and indentification as that species is quite understandable. This species compares favourably with others in the genus in regard to protoconch, type of sculpture, and shape of whorls and aperture.

Cancellaria (*Sydaphera*) *granosa* Sowerby, 1832
Figure 1, (8)

Cancellaria granosa Sowerby, 1832: 2, fig. 17.—Kiener, 1841: 30, pl. 8, fig. 1.—Sowerby, 1849: 443, pl. 95, figs 58, 59.—Reeve, 1856, pl. 5, fig. 20.—Brazier, 1884: 226.—Loebbecke, 1885: 48, pl. 14, figs 5, 6.—Tryon, 1885: 68, pl. 2, fig. 16.—Cotton and Godfrey, 1932: 55.

Sydaphera granosa.—Macpherson and Gabriel, 1962: 225, fig. 266.

Description: Protoconch $1\frac{1}{2}$ smooth, shining whorls, first half-whorl deviated, merging gradually into main whorls, nucleus submerged. *Teleoconch* 4 whorls, flatly convex, strongly shouldered. *Sutures* strongly impressed. *Sculpture* of strong rounded oblique axial ribs, 18–20 on body-whorl, 14 on penultimate, and strong spiral cords, 15 on body-whorl, 4 on penultimate; double cord at angle of shoulders, whole sculpture over-ridden by microscopic growth lines; sculpture

presents a grained or decussated appearance. *Umbilicus* a fine fissure behind inner-lip callus. *Aperture* ovate, tapering to short, broad open siphonal canal; columella straight, 3 weak oblique plaits, centrally situated; inner-lip recurved as strong callus over umbilical fissure; outer-lip regularly curved, thin, 10–12 lirations commencing on or a little below outer-lip and extending well into aperture. *Colour* pinkish-fawn with red-brown or grey-brown interstices between transverse cords, red-brown spots on shoulders; interior, including inner-lip, blotched with brown.

Type locality. Tasmania (Sowerby, 1849). South Australia (Brazier, 1884: 226).

Dimensions. Holotype, length 43 mm, breadth 25·3 mm. Average size approx. 33 mm x 20 mm.

Location of type. B.M.N.H. Reg'd No. 1968268.

Distribution. From Twofold Bay, N.S.W. (35° 06′ S., 149° 45′ E.), throughout Victoria, Tasmania (north and east coasts), King Island, and South Australia. Intertidal to 15–27 metres off Gabo Island, Victoria. Recorded as being taken alive on sand banks in Victoria, Macpherson and Gabriel (1962: 225).

Material. Twofold Bay as above, 2 specimens, A.M. No. C. 7819. South Australia, 1 specimen Kingston Beach (34° 89′ S., 139° 48′ E.), A.M. No. C. 74987. Tasmania, 11 specimens Ulverstone, N.W. coast, A.M. No. C. 75500. King Island as above (39° 48′ S., 143° 52′ E.), 2 specimens, A.M. No. C. 48997. Gabo Island as above, (37° 40′ S., 149° 34′ E.), 1 specimen, A.M. No. C. 74988.

A.M. 70 specimens (25 lots), N.M.V. 92 specimens (30 lots), S.A.M. 18 specimens (7 lots), others W.A.M. and Q.M. Total 191 specimens (66 lots).

Discussion. In his original description Sowerby referred to two figures, Nos 16 and 17, however Strong (1954: 17) showed the drawings to be those of two distinct species, and named the species based on fig. 16 as *Cancellaria peruviana*, giving the type locality as Peru. *C.* (*Sydaphera*) *granosa* is a lot less common than *C.* (*S.*) *undulata* and confined to a decidedly smaller area; main recognition point is the strong transverse cords crossing the axial ribbing in early whorls, compared with the finely incised lines crossing the ribs in *C.* (*S.*) *undulata.*

Cancellaria (*Sydaphera*) *lactea* Deshayes, 1830

Figure 2, (4) and (5)

Cancellaria lactea Deshayes, 1830: 180; 1843: 412.—Kiener, 1841: 36, pl. 6, fig. 4.—Reeve, 1856, pl. 18, fig. 82.—Loebbecke, 1885: 84; pl. 21, fig. 8.—Tryon, 1885: 74, pl. 3, fig. 51.—Cotton and Godfrey, 1932: 54, pl. 3, fig. 3.

Cancellaria laevigata Sowerby, 1832: 3, fig. 24; 1849: 448, pl. 92, fig. 16, pl. 96, fig. 81.—Reeve, 1856, pl. 8, fig. 34.—Chenu, 1859: 275, fig. 1825.—Loebbecke, 1885: 49, pl. 14, figs 7, 8; p. 90, pl. 23, figs 5, 6.

Cancellaria (*Euclia*) *laevigata* Tryon, 1885: 74, pl. 3, fig. 52.

Sydaphera lactea Macpherson and Gabriel, 1962: 225, fig. 267.

Description: Protoconch 2 smooth, shining, deviated whorls, merging gradually into main whorls, nucleus well submerged. *Teleoconch* $4\frac{1}{2}$ flatly convex whorls, shouldered, with strong subsutural ramp. *Sutures* well impressed. *Sculpture* of about 15 rounded axial ribs on early whorls, tending to disappear on body-whorl:

about 5 vague flat cords cross anterior end of body-whorl, with occasional traces of 3 or 4 others in centre. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* broadly ovate, contracted either end, a broad very short open siphonal canal; columella straight, 3 strong plaits, inner-lip recurved as strong callus over umbilical fissure; outer-lip flared outwards anteriorly, thickened but sharply-edged, 11 or 12 strong lirations extending well into aperture. *Colour* creamy-white, with cream-brown bands round body-whorl, usually leaving white bands in centre; irregular dark brown spots on top of shoulders.

Type of locality. Not stated.

Dimensions. Average measurement given by Deshayes (1843: 412), length 22–25 mm, breadth 13–15 mm, which is typical. Largest specimen examined is 32 mm x 17 mm.

Location of type. École des Mines, Paris. Reg'd No. not available.

Distribution. Smoky Bay, South Australia (32° 28′ S., 133° 54′ E.), eastwards to Western Port Bay, Victoria (38° 15′ S., 145° 20′ E.); northern and eastern Tasmania, southwards to Blackman's Bay, Hobart (42° 52′ S., 147° 17′ E.). Subtidal to 40 metres.

Material. Smoky Bay as above, 4 specimens, 40 metres (greatest depth recorded), A.M. No. C. 89748. Western Port Bay as above, 3 specimens, A.M. No. C. 74964. Blackman's Bay as above, 4 specimens, A.M. No. C. 89749.

A.M. 61 specimens (16 lots), N.M.V. 63 specimens (18 lots), S.A.M. 65 specimens (7 lots), sundry others, total 195 specimens (42 lots).

Discussion. This species appears to be seldom taken alive, but quite common in many places in a beach-worn condition, and usually with signs of a number of breakages. Axial ribbing is very variable, mainly on first two or three whorls, occasionally persisting on to body-whorl in an uneven manner. Although resembling *C.* (*Nevia*) *spirata* in form and colour, it is easily separated by the complete lack of a canal at top of shoulders.

Cancellaria (*Sydaphera*) sp.

Figure 2, (3)

Description: Shell small, whorls very convex, strongly ribbed, thin fawn periostracum. *Protoconch* 1½ smooth, shining, flatly convex whorls, first half-whorl deviated, merging gradually into main whorls, nucleus submerged. *Teleoconch* 4½ roundly convex, strongly ribbed whorls. *Sutures* deeply impressed. *Sculpture* of strong rounded oblique axial ribs, 12 on body-whorl and penultimate, crossed by strong spiral striae, 10 on body-whorl, 6 on penultimate, with 3 to 5 fine threads between each; cross striae form strong nodules, elongate and lateral, at intersections with ribs; fine threads between striae are granulated by crossing of microscopic growth lines. *Umbilicus* absent. *Aperture* ovate, a short wide open siphonal canal; columella straight with 2 strong oblique plaits, a third oblique fold bordering edge of anterior canal; outer-lip regularly curved, broken in specimen but obviously very thin and finely crenulate, no internal lirae. *Colour* fawn with narrow white central band on body-whorl adjoining sutural line; columella white.

Locality. East of Caloundra, southern Queensland (26° 48′ S., 153° 35′ E.), 109–128 metres.

Dimensions. Specimen is 16·9 mm length, 10·1 mm breadth.

Location of specimen. A.M., Sydney Reg'd No. C. 89278. ex. T. A. Garrard coll.

Distribution. Above locality only.

Material. Specimen is unique.

Discussion. This species bears a slight resemlance to *C.* (*Sydaphera*) *anxifer* Iredale, however the axial ribs on this new species are far stronger and bolder, the strong spiral lirae are not flat-topped as they are in *C.* (*S.*) *anxifer*, it has one white band and no brown bands, and the whorls are more globose and compressed, the shell therefore being broader for its length. It has been compared with the 32 specimens of *C.* (*S.*) *anxifer* in the A.M., and no connection can be found between the two species. Also any resemblance to *Admetula garrardi* Petit is superficial, the ribs being far stronger, the whorls more globose, 3 to 5 fine threads between each pair of transverse striae compared with one only in all specimens of *A. garrardi*, and the colour fawn with one white band contrasts with the light olive-brown of the latter, shading to fawn; in addition the 6–7 varices which distinguish specimens of *A. garrardi* are completely absent.

Cancellaria (*Sydaphera*) *panamuna** sp. nov.

Figure 2, (7)

Description: Protoconch 1½ smooth, slightly deviated convex whorls, nucleus slightly submerged, translucent, microscopic growth lines, merging gradually into adult sculpture. *Teleoconch* 4 convex whorls, finely cancellate; body-whorl 70 per cent of total length. *Sutures* well impressed. *Sculpture* of fine vertical axial ribs, about 50 on penultimate, crossed by transverse striae equal in strength to ribs, 8 on penultimate, about 18 on body-whorl, with one fine thread between each pair; ribs are finely nodular at intersections; whole sculpture crossed by microscopic growth lines. *Umbilicus* absent. *Aperture* elongate-ovate, contracted both ends, a very short siphonal canal; columella straight with 3 strong oblique plaits; inner-lip reflected as heavy white glaze on to body-whorl; outer-lip regularly curved, thick and heavy but sharply edged, 17 internal lirations. *Colour* off-white.

Type locality. 28 km N.W. of Anchor Island, off Onslow, Western Australia (21° 15′ S., 114° 38′ E.), 119 metres.

Dimensions. Holotype, length 17·2 mm, breadth 6·9 mm. Fully mature.

Location of type. W.A.M., Perth, Reg'd No. 551-71.

Distribution. Type locality, and 14 km N. of Long Island, near Onslow (21° 37′ S., 114° 38′ E.), also 161 km N. of Croker Island, Northern Territory (9° 30′ S., 132° 34′ E.), 77 to 124 metres.

Material. Holotype and 2 paratypes from type locality. "Western Australian —Hawaiian Exp." 7/1/60, W.A.M. No. 486-72. (2 paratypes), 1 specimen 10 km N.N.W. of Anchor Island, 84 metres, 17/6/60, same expedition, W.A.M. No. 552-71. 1 specimen 14 km N. of Long Island as above, 77 metres, same expedition, W.A.M. No. 551-71. 3 specimens N. of Croker Island as above, coll. P. H. Colman, 9/11/69, M.V. *San Pedro Sound*, 124 metres, B.M.R. Stn. P. 69-1144, A.M. No. C. 89364. W.A.M. 5 specimens (3 lots), A.M. 3 specimens (1 lot), total 8 specimens (4 lots).

Discussion. The only other species occurring in Australian waters which may be confused with this is the further new species *Fusiaphera dampierensis*, which

*A New South Wales Aboriginal noun meaning "Ocean."

is smaller but with similar but coarser sculpture, a much larger and more depressed protoconch, and the axis of the aperture much further inclined from the vertical. Compared with *C.* (*Sydaphera*) *purpuriformis* Valenciennes (below), this new species has many fine vertical axial ribs compared with the low oblique flattened ribs of *C.* (*S.*) *purpuriformis*, and the many fine transverse grooves in the latter species are replaced by fine raised striations, nodular at intersections with ribs.

Cancellaria (*Sydaphera*) *purpuriformis* "Valenciennes" in Kiener, 1841

Figure 2, (6)

Cancellaria purpuriformis Valenciennes (in Kiener), 1841: 37, pl. 7, fig. 4.—Sowerby, 1849: 448, pl. 95, figs 68, 70.—Reeve, 1856, pl. 16, fig. 76.—Loebbecke, 1885: 88, pl. 22, figs 9, 10.—Tate and May, 1901: 373.—Iredale, 1925: 264.

Cancellaria tasmanica Tenison-Woods, 1876: 150.

Cancellaria maccoyi Pritchard and Gatliff, 1899: 182, pl. 20, fig. 6.

Cancellaria purpuraeformis.—Cotton and Godfrey, 1932: 55.

Description: Protoconch 2 broadly obese whorls, smooth and shining, merging gradually into main whorls, nucleus not submerged. *Teleoconch* 4 convex whorls, body-whorl 75 per cent of total length. *Sutures* well impressed. *Sculpture*—finely transversely grooved throughout, 28–30 on body-whorl, up to 17 on penultimate, interspaces wider than grooves, more so in centre of body-whorl; broad, flattened oblique axial ribs commence about second whorl, becoming increasingly prominent on body-whorl; transverse grooves microscopically axially striated by growth lines. *Umbilicus* a small fissure behind recurved inner-lip callus. *Aperture* elongate-ovate, tapering sharply posteriorly, a short narrow open siphonal canal, recurved to left; columella straight, 3 strong oblique plaits, anterior plait forming edge of canal; inner-lip recurved as a thin glazed callus on to body-whorl and over umbilical opening, granulated anteriorly; outer-lip regularly curved, sharply edged, finely crenulate on inner-edge, some specimens with about 12 lirae extending into aperture. *Colour* off-white with two broad pale fawn bands on body-whorl, blotches of same colour below sutures and between ribs.

Type locality. Tasmania.

Dimensions. Holotype, length 20·25 mm. Maximum size approx. 30 mm x 18 mm. Beach-worn specimens are usually half grown.

Location of type. Whereabouts unknown.

Distribution. 27–36 metres (deepest record) off St Francis Island, South Australia (32° 35′ S., 133° 19′ E.), to Western Port Bay, Victoria (38° 15′ S., 145° 20′ E.), beach W. of Cape Portland, Tasmania (40° 45′ S., 148° 07′ E.), King Island, Tasmania (39° 45′ S., 143° 57′ E.). Subtidal to 36 metres.

Material. St Francis Island as above, 11 specimens, S.A.M. No. D. 7529. Western Port Bay as above, 1 specimen, A.M. No. C. 89753. Cape Portland as above, 1 specimen, A.M. No. C. 89752. King Island as above, 1 specimen, A.M. No. C. 48996.

S.A.M. 36 specimens (8 lots), N.M.V. 22 specimens (12 lots), A.M. 6 specimens (6 lots), total 64 specimens (26 lots).

Discussion. The protoconch of this species is not quite typical of the *C.* (*Sydaphera*) group, the nucleus not being submerged nor the first half-whorl deviated. However others features agree well with the type for the genus, *C.* (*S.*) *undulata* Sowerby. This species is seldom found alive and first-class specimens are a rarity. The nearest congener in general appearance is *C.* (*S.*) *lactea* Deshayes, but that species lacks the numerous transverse grooves which distinguish *C.* (*S.*) *purpuriformis* from all others in the genus.

Genus *FUSIAPHERA* Habe, 1961

Fusiaphera Habe, 1961: Append. 27. Type species by original designation *Cancellaria macrospira* A. Adams and Reeve, 1848.

References: Nil.

Diagnosis: Shells small, light in weight, fusiform, slightly canaliculate; up to 6 convex whorls, finely ribbed, 5–6 varices; aperture small, broad, contracted either end; umbilicus a very fine fissure; protoconch 2 smooth, shining, depressed whorls. (Differs from genus *Cancellaria* s.s. in being more elongately fusiform, invariably with varices, protoconch depressed and expanding rapidly in size, compared with tall prominent protoconch in *Cancellaria* s.s.).

Fusiaphera macrospira (A. Adams and Reeve, 1848)

Figure 3, (9)

Cancellaria macrospira A. Adams and Reeve, 1848: 41, pl. 10, fig. 2.—Reeve, 1856: pl. 11, fig. 50.—Loebbecke, 1885: 56, pl. 16, figs 7, 8.—Tryon, 1885: 76, pl. 4, fig. 67.—Chenu, 1859: 275, fig. 1818.—Crosse, 1861: 232.

Cancellaria (*Narona*) *macrospira;* Schepman, 1911: 263.

Fusiaphera macrospira.—Habe, 1961: 439.

Description: Protoconch 2 smooth, shining depressed whorls, expanding rapidly, merging gradually into main whorls, nucleus submerged. *Teleoconch* 6 convex whorls, constricted at base, a little canaliculate. *Sutures* deeply impressed. *Sculpture* of 12–14 rounded, slightly oblique axial ribs, together with one varix to each whorl, crossed by fine narrow transverse striations, 14 on body-whorl, 9 on penultimate, forming fine nodules at intersections with ribs; up to 7 microscopic hair-lines in between striae, central the strongest, crossed by microscopic growth lines; ribs scaly and recurved at top of shoulders, forming a fine coronation, some being continued as a low lamellate ridge to sutures at an oblique angle. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* widely elongate, contracted either end, forming a short narrow open siphonal canal, one strong tooth posteriorly; columella straight, 3 strong oblique plaits; inner-lip recurved as strong callus over umbilical opening; peritreme entire; outer-lip thickened but sharp-edged and crenulate, flared anteriorly. *Colour* off-white with broad light-brown band covering most of whorl, leaving a narrow white band above suture, and continued round centre of body-whorl; aperture white with brown deep in interior.

Type locality. Coast of Borneo, China Sea.

Dimensions. Holotype, length 23·5 mm, breadth 10 mm, which is average size.

Location of type. Should be with B.M.N.H. but reported lost.

Distribution. 18–27 metres E. of Great Keppel Island, Queensland (22° 53′ S., 150° 54′ E.). Only known Australian record. Appears to be distributed over a wide area northwards to Japan.

Material. One specimen as above, ex. T. A. Garrard coll., presented to A.M. Sydney, Reg'd No. C. 89277.

Discussion. Further specimens are stated verbally to have been found in Queensland waters but definite confirmation not available. The above specimen is in very good condition and identification is certain. (See fig. 3 (9).)

Fusiaphera dampierensis sp. nov.

Figure 2, (8)

Description: Protoconch 2½ smooth shining whorls, convexly flattened, expanding rapidly, merging gradually into main whorls, nucleus slightly submerged. *Teleoconch* 4 globose whorls, rounded at shoulder, straighter at base. *Sutures* deeply impressed. *Sculpture* of fine sharp axial riblets, 21 on body-whorl, up to 24 on penultimate, crossed by strong transverse striae, 21 on body-whorl, 10 on penultimate, forming fine nodules at intersections with riblets; transverse striae are crossed by fine hair-lines of growth; several varices frequently present. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* broad, ovate, tapering either end; outer-lip thin with heavy varix at rear, 12 strong lirations within aperture, one strong posterior tooth; columella straight but set at oblique angle to left; inner-lip strongly reflected on to body-whorl, peritreme entire; 3 strong oblique plaits from centre of columella to anterior end, short broad open siphonal canal. *Colour* off-white with slight fawn tinge in places.

Type locality. 11–12 km N. of Delambre Island, Dampier Archipelago, northwestern Australia (20° 30′ S., 116° 25′ E.), 40 metres.

Dimensions. Holotype, length 11·6 mm, breadth 6·6 mm. Largest specimen examined, 14 mm length, 6·9 mm breadth.

Location of type. W.A.M., Perth, Western Australia, Reg'd No. 550-71.

Distribution. Type locality to N. of Long Island, near Onslow, W.A., (21° 36′ S., 114° 39′ E.), 75 metres, greatest depth recorded. Also one damaged specimen, body-whorl only, from 54 metres off Darnley Island, Torres Strait (9° 40′ S., 143° 50′ E.).

Material. Holotype, coll. 9/6/60 (no varices). One paratype 11 km N. of Long Island near Onslow, W.A., 51 metres, coll., 17/6/60, 13·5 mm x 6·5 mm (7 varices at irregular intervals), W.A.M. Reg'd No. 434-72. One further paratype 16 km N. of Long Island, near Onslow as above, 75 metres, coll. 17/6/60, 14 mm x 6·9 mm (6 varices at irregular intervals), W.A.M. Reg'd No. 435-72. Above damaged specimen from Darnley Island in 1877, collected and recorded by Brazier as *Cancellaria australis* Sowerby. Held by Macleay Museum, University of Sydney, unregistered. A specimen is also held by W.A.M. (Reg'd No. 436-72), from 109–128 metres off Laoy Island, near Bohol Island, Philippine Islands, measuring 13·5 mm x 6·3 mm coll. 9/2/64, "Pele Sulu Exped." The specimen has a few less axials than the W.A. specimens, also the transverse and intermediate striae are a little finer, and it has one varix.

Discussion. Although broader for its length than other species in the genus *Fusiaphera*, this new species has the same depressed rapidly expanding protoconch, varices common to the genus, same general slightly coronated whorl formation, slightly canaliculate, and same type of aperture; the aperture has the axis titled at 30° from the vertical, which is common to the other two species in the genus found in Australia.

This species differs from *Fusiaphera macrospira* in being decidedly broader for its length, whorls more convex, it has more numerous and sharper axial ribs, also stronger and more numerous transverse striae, in addition to which it grows to only half the size.

From *Fusiaphera pallida* it differs in having a greater number of axial ribs, closer spacing being very obvious in penultimate and earlier whorls, a greater number of transverse striae, and ribs are not scale-like at sutures.

Fusiaphera pallida (E. A. Smith, 1899)

Figure 2, (9) and (12)

Cancellaria pallida E. A. Smith, 1899: 313, text fig. 4.

Description: Protoconch 2½ convex whorls, expanding rapidly but depressed, nucleus glass-like and slightly elevated. *Teleoconch* 4½ whorls, evenly convex. *Sutures* well impressed. *Sculpture* of very fine narrow axial ribs, widely spaced, recurved and scale-like at sutures, 12 on body-whorl in addition to 2 varices, 10 ribs and 2 varices on penultimate, crossed by very fine striae, 7 on penultimate, 18 on body-whorl, sharply nodular at intersections with ribs; whole sculpture crossed by microscopic growth lines. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* widely ovate, peritreme entire; columella straight but inclined to left, 3 strong oblique plaits; inner-lip strongly recurved on to body-whorl; outer-lip regularly curved, strongly variced and reflected, sharply-edged, 15 strong lirations extend well into aperture; one tooth posteriorly; a short wide siphonal canal anteriorly. *Colour* pale ivory, aperture white.

Type locality. Off Cassini Island, northwestern end of Bonaparte Archipelago, northwestern Australia (14° 56′ S., 125° 38′ E.), 45 metres.

Dimensions. Holotype, length 10·5 mm, breadth 6 mm. Largest specimen examined, length 11·2 mm, breadth 5·8 mm. Apparently fully grown.

Location of type. B.M.N.H. Reg'd No. 1891.11.21.96.

Distribution. Type locality to Arafura Sea, 161 km N. of Croker Island, Northern Territory (9° 30′ S., 132° 34′ E.), 124 metres. Only two localities and depths known.

Material. Holotype coll. J. J. Walker, H.M.S. *Penguin.* (Fig. 2 (9).) One mature specimen (fig. 2 (12)) and two immature specimens from Arafura Sea as above, coll. P. H. Colman, 9/11/1969, M.V. *San Pedro Sound.* (B.M.R. Stn. P69-1144). A.M. Reg'd No. C. 89268.

Discussion. It is fortunate that further specimens of this small species have been found after a lapse of over 70 years, confirmation always being desirable when any new species is named from a unique specimen.

Compared with *Fusiaphera macrospira* (A. Adams and Reeve), type for the genus, this species grows to only half the size, whorls are more depressed and only $4\frac{1}{2}$ compared with 6 whorls in *F. macrospira*, also the oblique axial ribs are decidedly finer and narrower.

Genus *TRIGONOSTOMA* Blainville, 1827

Trigonostoma Blainville, 1827: 652. Type species by monotypy *Delphinula trigonostoma* Linnaeus, 1758.

References: Adams, H. and A., 1854: 276; Chenu, J. C., 1859: 276; Tryon, G. W., 1885: 65; Jousseaume, F., 1888: 22; Cossmann, M., 1899: 24; Keen, A. M., 1971: 656; Wenz, 1938–44: 1358.

Synonyms: Arizelostoma Iredale, 1936. Type species by original designation *Arizelostoma laseroni* Iredale, 1936. It is considered that the diagnosis of *Trigonostoma* as shown below covers all the main points of *T. laseroni* Iredale, with the exception of the more depressed form of spire, which is not sufficient grounds for separation.

Cancellaphera Iredale, 1930. Type species by original designation *Cancellaphera amasia* Iredale, 1930. In this species also, all the main features agree well with those of the genus *Trigonostoma*, the trigonal aperture, turreted and flatly canaliculate whorls and cancellate sculpture, and *Cancellaphera* must also be regarded as a synonym.

Diagnosis: Shells small to medium, whorls broadly and flatly canaliculate, turreted, strongly contracted at base, finely ribbed and transversely striated, sutures deeply impressed; aperture trigonal and oblique; umbilicus small or large and deep; body-whorl oblique; protoconch $1\frac{1}{2}$ to 2 smooth, shining whorls, regular or deviated.

Note: The Tertiary fossil species *Cancellaphera confirmans* Ludbrook, 1958 should be placed in this genus.

Owing to the similarity in features of many species usually divided between the subgenera *Trigonostoma*, *Scalptia* and *Trigonaphera*, and to avoid making arbitrary decisions, the genus *Trigonostoma*, s.l. has been used to contain all species in this group.

Trigonostoma amasia (Iredale, 1930)

Figure 3, (11) and (12)

Cancellaphera amasia Iredale, 1930: 80, pl. 9, fig. 8.

Description: Protoconch $1\frac{1}{2}$ smooth, shining, convex whorls, merging gradually into adult sculpture, nucleus slightly submerged. *Teleoconch* 4 whorls, flatly convex, body-whorl greatly inflated, becoming increasingly canaliculate. *Sutures* deeply impressed. *Sculpture* of sharp oblique axial ribs, 15 on body-whorl, 18–21 on penultimate, crossed by fine transverse striae, about 12 on body-whorl with a finer thread between, 4 on penultimate; whorls are shouldered, with ribs continuing at oblique angle across sutural canal, and ribs are sharply nodular at intersections with spirals. *Umbilicus* small and deep, with ribs continued into opening. *Aperture* elongate-ovate, one sharp tooth posteriorly, short broad open siphonal canal; columella straight with 3 sharp plaits, posterior and central oblique; anterior horizontal; inner-lip strongly calloused, partly reflected over umbilicus,

outer-lip regularly curved, sharp-edged and serrated, 10–12 strong lirations extending well into aperture. *Colour*—unicoloured white, yellow, fawn, purple or various shades of brown.

Type locality. Port Curtis, Queensland (23° 47′ S., 151° 15′ E.), 16–20 metres.

Dimensions. Holotype, length 15 mm, breadth 10 mm. Normal size. Largest specimen examined 25 mm x 17 mm.

Location of type. A.M., Sydney. Reg'd No. C. 57740.

Distribution. Port Douglas, north Queensland (16° 27′ S., 146° E.), southwards along Queensland coast to Wooli, New South Wales (29° 35′ S., 152° 57′ E.); greatest depth 118–146 metres N.E. of Cape Moreton, southern Queensland (26° 55′ S., 153° 34′ E.). Subtidal to 146 meters.

Material. Port Douglas as above, 1 specimen, W.A.M. No. 547-71. Wooli as above, 2 specimens, N.M.V., not reg'd. Greatest depth as above, 1 specimen, ex. T. A. Garrard coll., A.M. No. C. 90076.

A.M. 195 specimens (36 lots), N.M.V. 14 specimens (5 lots), W.A.M. 4 specimens (2 lots), Q.M. 3 specimens (2 lots), total 216 specimens (45 lots).

One dark brown specimen, Broome Creek, Roebuck Bay, W. Aust., (17° 58′ S., 122° 27′ E.), ex. Beresford Bardwell coll., N.M.V. Reg'd No. F. 27470. One further dark brown specimen, muddy sand, Roebuck Bay, coll. N. Coleman, 23/10/72, A.M. No. C. 96134. Only known Western Australian records.

Discussion. Several paratypes of the fossil species *Cancellaphera confirmans* Ludbrook, from Weymouth Bore, Adelaide, South Australia, have been forwarded for inspection, Reg'd No. 15412B. These show a strong resemblance to *T. amasia*, although the protoconch on all paratypes is 3 times the size of that on *T. amasia*, but similar in form. Both species have a peculiar scale-on-scale sculpture found in species of Muricidae, but horizontal instead of vertical.

Trigonostoma antiquata (Hinds, 1843)

Figure 3, (16)

Cancellaria antiquata Hinds, 1843: 49; 1844: 43, pl. 12, figs 17, 18.—Sowerby, 1849: 458, pl. 93, fig. 27.—Reeve, 1856, pl. 16, fig. 74.—Chenu, 1859: 276, fig. 1835.—Loebbecke, 1885: 57, pl. 16, figs 9, 10.—Tryon, 1885: 79, pl. 5, fig. 88.

Trigonostoma antiquata.—Habe, 1961: 435, pl. 23, fig. 8; pl. 24, fig. 14.

Description: Protoconch 2 convex whorls, expanding rapidly, smooth and shining, finishing abruptly at commencement of adult sculpture. *Teleoconch* 4½ whorls, slightly convex, very narrow at base, expanding rapidly to prominent shoulders where they curve inwards; flat area between shoulders and sutures canaliculate. *Sutures* well impressed. *Sculpture* of 12 very fine but sharp axial ribs on penultimate and body-whorl, crossed by 7 fine evenly spaced striae, forming very small nodules at intersections with ribs, and 3 microscopic threads between each striation; fine irregular microscopic growth lines cross threads between ribs; the ribs cross a cingulum at base of umbilicus into opening and terminate abruptly; ribs show scale-on-scale formation on reaching shoulders, curving inwards over flat canaliculate area, which has fine densely packed striae radiating from sutures to shoulders, crossed by microscopic spiral striae; this flat area also has fine radiating ridges, raised and sharp near sutures, fading towards shoulders. *Umbilicus* large and extending through

shell to protoconch, with very fine close-packed axial striae crossed by microscopic growth lines. *Aperture* trigonal, outer-lip thickened by densely packed growth lines and slightly reflected, about 14 lirations within; columella almost straight, two slightly oblique plaits, not prominent, occasionally a further almost obsolete plait at either or both ends; inner-lip slightly flared over umbilicus, peritreme entire; a narrow open siphonal canal, curved towards outer-lip. *Colour* off-white, occasionally with one or two pinkish-brown bands; thin cream coloured periostracum.

Type locality. New Guinea, 40 metres.

Dimensions. Holotype, length 14·77 mm. Average size 23 mm x 15 mm. Largest specimen examined 27 mm x 20 mm.

Location of type. B.M.N.H. Reg'd No. 1968416.

Distribution. From Carnarvon, Western Australia (24° 55′ S., 113° 46′ E.) across northern Australia and southwards along Queensland coast to Wide Bay (25° 47′ S., 153° 09′ E.). Greatest depth 124 metres, 161 km N. of Croker Island, Northern Territory (9° 30′ S., 132° 34′ E.). Widespread throughout Indonesia and Philippine Islands to Japan.

Material. Carnarvon as above, 1 specimen ex. J. Kerslake coll., June 1962, A.M. No. C. 68924. Wide Bay as above, 1 specimen, 58 metres, ex. T. A. Garrard coll., A.M. No. C. 89762. Greatest depth, N. of Croker Island as above, 2 specimens, coll. P. H. Colman 9/11/1969, M.V. *San Pedro Sound*, B.M.R. Stn. P.69-1144, A.M. No. C. 90362. A.M. 5 specimens (4 lots), N.M.V. 2 specimens (2 lots), W.A.M. 1 specimen from Malanipa, Mindanao, Philippine Islands, 36 metres, "Pele Sulu Exped." 12/2/64, W.A.M. No. 579-71. Total Australian specimens 7 (6 lots).

Discussion. Records by Angas (1877: 186) for variety from Port Jackson and Port Stephens, New South Wales, probably refer to species *Trigonostoma bicolor* Hinds (= *Trigonaphera interlaevis* Laseron olim.).

The fine sculpture on this species gives the impression under magnification of finely woven linen.

Trigonostoma bicolor (Hinds, 1843)

Figures 3, (10) and 5, (4)

Cancellaria bicolor Hinds, 1843: 48; 1844: 43, pl. 12, figs 13, 14.—Sowerby, 1849: 456, pl. 94, figs 49, 50; pl. 95, fig. 69.—Reeve, 1856, pl. 7, fig. 29.—Loebbecke, 1885: 87, pl. 22, figs 3, 4.—Tryon, 1885: 79, pl. 5, fig. 86, pl. 6, figs 89, 90.

Trigonaphera bicolor.—Habe, 1961: 436, pl. 23, figs 1, 2.

Cancellaria (*Trigonostoma*) *bicolor;* Schepman, 1911: 263.

Cancellaria septemcostata Ohdner, 1917: 55, pl. 2, fig. 57.

Trigonaphera interlaevis Laseron, 1955: 270, fig. 9.

Description: Protoconch 2 smooth shining whorls, depressed, ending abruptly at commencement of main sculpture, nucleus submerged. *Teleoconch* 4 flatly convex whorls, a little constricted at base. *Sutures* well impressed. *Sculpture* of 6–8 sharply raised narrow ribs on each whorl, continuing across shoulders to sutures at oblique angle, crossed by faint transverse striae, about 10 ou body-whorl, with a

finer thread between; these are barely discernible in interstices, but form narrow prominent nodules in crossing ribs; faint punctures in irregular longitudinal rows occur spasmodically on some specimens (Ohdner, 1917: 55); whole sculpture is crossed by microscopic growth lines; space between shoulders and sutures slightly canaliculate, ribs prominent with sharp serrated edges. *Umbilicus* medium and deep, continuing through to spire, and with ribs continuing over edge into opening. *Aperture* trigonal, narrowing anteriorly to short open siphonal canal; columella straight with 3 strong oblique plaits; inner-lip reflected as heavy callus on to body-whorl and partly over umbilicus; peritreme entire: outer-lip widely flared outwards, thin, sharp and serrated, 9 internal lirations continuing well into aperature. *Colour* light cream or chestnut, dark red-brown line at sutures between ribs, often continued as broad band round centre of body-whorl, spot of same colour on tip of each rib at shoulders; aperture white-edged, usually brown internally.

Type locality. Straits of Macassar (01° N.–04° S., 117°–118° E.), 18 metres.

Dimensions. Holotype, length 23·21 mm, average size 18 mm high, 12 mm wide. Holotype is maximum size.

Location of type. B.M.N.H. Reg'd No. 1968413.

Distribution. De Puch Island, Dampier Archipelago, Western Australia (20° 27′ S., 117° 05′ E.). Broome Beach, Western Australia, Darwin, Northern Territory (12° 25′ S., 130° 50′ E.). Albany Passage, Torres Strait, and southwards along Queensland and New South Wales coasts to Cronulla, New South Wales (33° 54′ S., 151° 06′ E.). Mainly subtidal to 70–80 metres. A widespread species which extends through Indonesia and Philippine Islands to Japan.

Material. De Puch Island as above, 1 specimen, "Western Australian-Hawaiian Exped." 6/6/60, W.A.M. No. 555-71. 1 specimen marked "N.W.Aust." T.M., Hobart, No. E. 4662. Broome Beach as above, 2 specimens, Mel. Ward coll., A.M. No. C. 86376. Darwin as above, 1 specimen, Q.M., not reg'd. Albany Passage as above, 2 specimens, coll. C. Hedley, A.M. No. C. 89760. Cronulla as above, 1 specimen, 70–80 metres (deepest record), coll. J. McIntyre, Aug. 1964, A.M. No. C. 89761.

A.M. 33 specimens (18 lots), N.M.V. 9 specimens (5 lots), W.A.M. 5 specimens (3 lots), others 4 specimens (4 lots), total 51 specimens (30 lots).

Discussion. Ohdner's description of his *Cancellaria septemcostata* (1917: 55) with only 7 ribs, and faint punctures in longitudinal rows, is in keeping with numerous specimens from Queensland. Similarly, specimens of *Trigonaphera interlaevis* Laseron from New South Wales prove to be small pale-coloured *Trigonostoma bicolor*, apparently stunted in form and lacking much of the usual colour pattern through living in more temperate regions at the end of the range of distribution. The two specimens mentioned above from Albany Passage, Torres Strait, are from 16–22 metres, and have 16 fine red-brown hair-lines round body-whorl, 4 on penultimate, in lieu of one, two or even three broader red-brown bands found on some specimens.

Trigonostoma diamantina sp. nov.

Figure 3, (4)

Description: Protoconch large, prominent, translucent white, 1½ convex whorls, first half-whorl deviated, merging gradually into adult sculpture, nucleus

submerged. *Teleoconch* 4½ whorls, strongly shouldered and turreted, flatly canaliculate, flatly convex, constricted at base. *Sutures* deeply impressed. *Sculpture* of thin, fine, sharp-edged vertical axial ribs or ridges, becoming flattened with age, 9 on body-whorl, 12 on penultimate and next whorl, elevated above shoulders, scale-on-scale formation and reflected backwards, continued obliquely across top of shoulders to sutures as very fine raised lines, numerous fine growth lines between; transverse sculpture of numerous tightly packed and extremely fine rounded striae, crossed by microscopic growth lines. *Umbilicus* a slight indentation towards base of inner-lip callus. *Aperture* elongate-ovate, constricted either end, obliquely truncated posteriorly and with one low rounded tubercle, short broad open siphonal canal anteriorly; inner-lip reflected as strong callus on to body-whorl; outer-lip thin and sharp but thickened into heavy varix at rear, consisting of fine closely packed lamellae; seven fine low lirations internally; columella straight, two strong scarcely oblique plaits in centre, a third fold forms edge of canal. *Colour* off-white or grey white, aperture pure white.

Type locality. North-west of Bunbury, Western Australia (33° 10′ S., 115° 18′ E.), 201–228 metres.

Dimensions. Holotype, length 12·6 mm, breadth 7·2 mm. Specimen is apparently fully mature.

Location of type. W.A.M., Perth, Western Australia, Reg'd No. 490-72.

Distribution. Type locality, and S.W. of Mandurah, Western Australia (33° 05′ S., 115° 18′ E.), 220 metres.

Material. Holotype, coll., H.M.A.S. *Diamantina*, 17/3/72, Stn. 24, (D.M. 1/72). One paratype S.W. of Mandurah as above, coll., H.M.A.S. *Diamantina*, 17/3/72 (D.M. 1/72). Length 11·7 mm, breadth 6·8 mm. W.A.M. Reg'd No. 437-72.

Discussion. This fine small species is closest to *Trigonostoma vinnula* Iredale, from New South Wales, having most features in common, but can be identified readily by the stark white aperture contrasting with the greyish-white colour of the shell; no specimen of *T. vinnula* has been observed which is other than a light shade of brown or fawn with a narrow white band round body-whorl. In addition this new species has vertical and not oblique axial ribs, also the sides of whorls and the outer-lip of aperture are far flatter in outline than the convex whorls and outer-lip of *T. vinnula*.

Trigonostoma iota sp. nov.

Figure 3, (3)

Description: Protoconch 2¼ smooth, shining, flatly convex whorls, merging gradually into main sculpture, nucleus slightly submerged. *Teleoconch* 4¼ convex whorls, body-whorl 73 per cent of total length. *Sutures* strongly impressed at base of slight canal. *Sculpture* of strong rounded oblique axial ribs, 9 to each whorl; whorls square shouldered, coronate, ribs continued across top of shoulders obliquely to sutures as sharp ridges; 5, 6 and 7 transverse striae on first 3 whorls respectively, 10–12 on body-whorl, with one fine thread between each pair; striae form smooth rounded nodules on first two whorls at points of intersection with ribs, becoming more elongate on penultimate and body-whorl, forming a lamellate effect and recurved inwards towards sutures. *Umbilicus* deep and narrow with fine growth lines internally, ribs terminating at outer edge. *Aperture* elongate-ovate, truncated

and toothed posteriorly, peritreme entire; outer-lip regularly curved, reflected and thickened, hollow-edged internally, 12 strong internal lirations; columella straight with 3 strong oblique plaits; siphonal canal short, open and narrow; inner-lip reflected as strong callus on to body-whorl and partly over umbilicus. *Colour* of protoconch and first whorls light brown, fading on body-whorl to pale fawn; nodules and top of shoulders white; aperture light brown.

Type locality. N.E. of Cape Moreton, southern Queensland (26° 47′ S., 153° 40′ E.), 114–124 metres.

Dimensions. Holotype, length 13·2 mm, breadth 7·1 mm, ex. J. Kerslake coll. Appears to be fully grown.

Location of type. A.M., Sydney, Reg'd No. C. 89274.

Distribution. Apart from type locality, only other specimen is from 36 metres off Hervey Bay, southern Queensland (25° S., 152° 35′ E.).

Material. Holotype and one paratype as above, 11·6 mm x 6·4 mm, ex. T. A. Garrard coll., A.M. Reg'd No. C. 89294.

Discussion. This small species bears a slight resemblance to a small specimen of *Trigonostoma scalarina* (Lamarck) but is quite distinct, and as two specimens are held from different localities, identical in form and sculpture, it is considered that description as a distinct species is warranted. The width/length ratio in *T. scalarina* is 63 per cent, and in this new species only 55 per cent; the nodules on first two whorls tipped with white are quite pronounced and distinct from the sharply serrated ribs where crossed by the transverse striae in *T. scalarina;* the two transverse striations on top of the shoulders, forming a lamellate effect in the penultimate and body-whorl, recurved towards the sutures, contrast with the lamellate ribs on top of shoulders in *T. scalarina* recurved backwards from the aperture. In addition the two specimens, whilst almost certainly fully mature, are little more than half the size of an average specimen of *T. scalarina* with the same number of whorls.

Trigonostoma lamellosa (Hinds, 1843)

Figure 3, (13)

Cancellaria lamellosa Hinds, 1843: 49; 1844: 43, pl. 12, figs 15, 16.—Sowerby, 1849: 453, pl. 94, fig. 47; pl. 96, fig. 106.—Reeve, 1856, pl. 15, fig. 65.—Brazier, 1877: 312.—Loebbecke, 1885: 55, pl. 16, figs 5, 6.—Tryon, 1885: 80, pl. 6, fig. 98.

Cancellaria (*Trigonostoma*) *lamellosa*.—Schepman, 1911: 264.

Description: Protoconch 2 smooth shining whorls, merging gradually into main whorls, nucleus slightly submerged. *Teleoconch* 5 whorls, first 3 almost flat, penultimate and body-whorl convex, strongly shouldered and becoming increasingly canaliculate with age. *Sutures* well impressed, at base of deep canal. *Sculpture* 12–14 sharp and very oblique ribs, forming prominent sharp scaly projections on shoulders, inclined to right, continued across canal to sutures as sharp oblique ridges; ribs crossed by about 15 sharply raised transverse striae on body-whorl, 8 on penultimate; ribs cross into umbilical opening as sharp raised striae; ribs consist of lamellations, mostly in pairs, but often up to 8, densely packed in 2 or 3 places including outer-lip, as maturity is reached. *Umbilicus* broad and deep, with inner-lip of aperture strongly reflected over the opening. *Aperture* subtrigonal, tapering anteriorly to a narrow open siphonal canal, reflected towards outer-lip; peritreme

entire; very small tooth posteriorly; outer-lip heavily thickened, slightly reflected and sharply-edged, 11–12 lirae within; columella curved to right, plaits 3, evenly spaced, all slightly oblique. *Colour* white with dark brown band below shoulders, not showing on ribs, wide pale brown band below this then narrow white band, followed by thin red-brown line; dark brown patches deep in aperture.

Type locality. "Indian Archipelago". (Possibly intended to mean Lacadive Islands-Maldive Islands groups).

Dimensions. Holotype, length 15·8 mm. Maximum dimensions approx. 22 mm x 16 mm.

Location of type. B.M.N.H. Reg'd No. 1968414.

Distribution. 32 km N. of Delambre Island, Dampier Archipelago, Western Australia (20° 27′ S., 117° 05′ E.), southwards to S.E. corner of Dirk Hartog Island, W. Aust. (26° 05′ S., 113° 15′ E.).

Material. Delambre Island as above, 1 specimen, 41 metres, "Western Australian-Hawaiian Exped." 7/6/60. W.A.M. No. 566-71. Rosemary Island, Dampier Archipelago, 1 specimen, 4–7 metres, coll. B. R. Wilson, Aug., 1961, W.A.M. No. 537-71 (figured pl. 3, fig. 13). Dirk Hartog Island, as above, 1 specimen, 4–7 metres, coll. B. R. Wilson, March, 1966, W.A.M. No. 538-71. 13 specimens, Broome, W. Australia, N.M.V. coll., not reg'd, also 2 others same locality, Reg'd No. F. 4573.

W.A.M. 3 specimens (3 lots), N.M.V. 15 specimens (2 lots), total 18 specimens (5 lots).

Discussion. This species has been regarded by some workers in the past as a synonym of *Cancellaria scalarina* Lamarck, however examination of a number of specimens of each species from numerous localities shows them to be distinct. *T. lamellosa* has a lower spire, with body-whorl averaging 85 per cent of total length. compared with 78 per cent in *T. scalarina*, which species also has the umbilicus decidedly closer to the anterior end of shell. The axial ribs in *T. lamellosa*, also the columella, are more oblique, the ribs are composed of 2 or 3 lamellations, closely packed but quite distinct with sharp edges, which also applies to the recurved scaly projections on top of shoulders; the numerous densely packed lamellae forming the mature outer-lip are also separated to a certain extent, and not firmly fused together and glazed over as in *T. scalarina*, presenting in that species a much more solid appearance.

Trigonostoma laseroni (Iredale, 1936)

Figure 4, (12) and (13)

Arizelostoma laseroni Iredale, 1936: 318, pl. 24, fig. 9.—Laseron, 1955: 271, fig. 10.

Description: Protoconch 1½ smooth, shining whorls, merging gradually into adult sculpture, nucleus submerged. *Teleoconch* 3½ flatly convex whorls, sharply angled at shoulder, flatly canaliculate, constricted at sutures. *Sutures* strongly impressed. *Sculpture* of rounded, irregularly shaped, oblique axial ribs, about 8 on body-whorl, 10–12 on penultimate, crossed by flatly rounded cords, 5 on body-whorl, 3 on penultimate, nodular at intersections with ribs; 3–4 minor striations between each pair of cords, all crossed by microscopic growth lines; ribs cross shoulders in form of flatly rounded ridges leading across canaliculate depression to

sutures. *Umbilicus* large, leading through to protoconch; up to 10 flat irregular cords anteriorly, crossed by microscopic growth lines. *Aperture* trigonal, short narrow open siphonal canal; peritreme entire; columella straight with 2 strong central plaits, slightly oblique; inner-lip reflected partly over umbilicus as strong callus; outer-lip flared outwards anteriorly, thin and crenulated, 10–12 internal lirations in some specimens, often absent. *Colour* white, cream, pink or various shades of orange-brown; many light coloured specimens with triangular dark patches in canaliculate depression on top of shoulders; occasionally a narrow brown band in centre of whorls, and a second band on body-whorl.

Type locality. Shellharbour, New South Wales (34° 35′ S., 150° 57′ E.).

Dimensions. Holotype, length 7 mm, breadth 7 mm. Largest specimen examined, length 21 mm, breadth 18 mm. Average size 18 mm x 14 mm.

Location of type. A.M. Sydney, Reg'd No. C. 60686.

Distribution. Furthest north and greatest depth recorded, 54 metres off Laurieton, N.S.W. (31° 40′ S., 152° 54′ E.), southwards along New South Wales coast to Bermagui (36° 50′ S., 150° 03′ E.). Subtidal to 54 metres.

Material. Off Laurieton as above, 1 specimen ex. T. A. Garrard coll., A.M. No. C. 89763. Bermagui as above, 2 specimens, A.M. No. C. 89764. 1 specimen taken alive under rock, 16 metres in Wreck Bay, N.S.W. (35° 08′ S., 150° 36′ E.), 28/10/70, A.M. No. C. 92192. A.M. 21 specimens (9 lots), N.M.V 5 specimens (3 lots), S.A.M. 5 specimens (3 lots), total 31 specimens (15 lots).

Discussion. Apart from the finer ribbing on this species, it bears a striking resemblance to the larger *Trigonostoma goniostoma* Sowerby from central America, with the same general formation, umbilicus, aperture, dark patches between ribs on top of shoulders, and the presence of two plaits on columella.

Trigonostoma obliquata (Lamarck, 1822)

Figure 3, (17)

Cancellaria obliquata Lamarck, 1822: 115.—Sowerby, 1832: 4, fig. 26.—Kiener, 1841: 21, pl. 6, fig. 2.—Deshayes, 1843: 408.—Sowerby, 1849: 453, pl. 96, figs 82, 83.—Reeve, 1856: pl. 13, fig. 61.—Loebbecke, 1885: 60, pl. 17, figs 4, 5.—Tryon, 1885: 81, pl. 6, fig. 1.

Cancellaria (Trigonostoma) obliquata.—Schepman, 1911: 264.

Description: Protoconch 2 globose whorls, smooth and shining, microscopic growth lines, merging gradually into main whorls. *Teleoconch* 5 convex whorls, strongly shouldered, canaliculate. *Sutures* impressed, at base of deep narrow canal. *Sculpture* of strong slightly oblique rounded ribs, 14–15 on both body-whorl and penultimate, crossed by 11–12 fine transverse striae, forming sharp translucent-white nodules on ribs; sharp and prominent scales on shoulders, inclined to right, continued obliquely as fine sharp ridges across canal to sutures; a few vague threads between cross striae; ribs cross edge of umbilicus and continue as fine sharply-raised striae well into aperture. *Umbilicus* small but deep, partly covered by strongly reflected inner-lip callus. *Aperture* ovate with short open siphonal canal, one strong tooth posteriorly; outer-lip heavy, reflected and formed of several closely-packed sharply raised lamellae; 10–12 lirae within aperture, commencing short distance from edge of lip; columella straight, plaits 3, evenly spaced, posterior and central oblique,

anterior horizontal; inner-lip reflected as strong callus on to body-whorl, peritreme entire. *Colour* translucent white or pale pink, 2 to 4 fine red-brown horizontal lines on top of ribs between each main transverse striation; background frequently tinted pale blue.

Type locality. New Caledonia.

Dimensions. Holotype, length 19·12 mm. Largest specimen examined 20 mm x 16 mm, average 18 mm x 14 mm.

Location of type. Museum d'Histoire Naturelle, Geneva. Reg'd No. 1097/91.

Distribution. 10 km N. of Long Island, near Onslow, Western Australia, (21° 39′ S., 114° 35′ E.), eastwards to Darnley Island, Torres Strait, and Murray Island, Torres Strait (9° 58′ S., 144° 02′ E.). Subtidal to 55 metres.

Material. N. of Long Island as above, 1 specimen, 51 metres. "Western Australia-Hawaiian Exped.", 17/6/60. W.A.M. No. 556/71. Off Darnley Island as above, 1 specimen, 55 metres, A.M. No. C. 8001 (pt). Off Murray Island as above, 3 specimens, 9–14 metres, A.M. No. C. 30020. A.M. 14 specimens (6 lots), W.A.M. 12 specimens (3 lots), S.A.M. 8 specimens (1 lot), N.M.V. 3 specimens (2 lots), total 37 specimens (12 lots), all New Caledonia apart from 5 Australian specimens detailed.

Discussion. This species can be confused with *T. lamellosa* Hinds, having the same type of oblique body-whorl; canaliculate sutures and densely packed lamellate outer-lip at maturity; however it can be separated by its finely spinose sculpture on all ribs, tipped with numerous fine red-brown spots; this contrasts with the sharply raised lamellate ribs of *T. lamellosa*, with recurved scaly projections on top of shoulders; the figure at figure 3 (13) is enlarged to emphasize these features.

Trigonostoma scalariformis (Lamarck, 1822)

Figure 4, (3) and (4)

Cancellaria scalariformis Lamarck, 1822: 113.—Kiener, 1841: 12, pl. 5, fig. 4.—Deshayes, 1843: 404.—Tryon, 1885: 80.

Cancellaria costifera Sowerby, 1832: 5, sp. 33, fig. 31.—Sowerby, 1849: 456, pl. 95, figs 65, 66, 71.—Reeve, 1856, pl. 12, fig. 57.—Loebbecke, 1885: 74, pl. 19, figs 9–14.—Tryon, 1885: 82, pl. 7, figs 12, 13.

Cancellaria nitida Reeve, 1855, pl. 17, fig. 78.

Cancellaria mangelioides Reeve, 1856, pl. 15, fig. 69.

Cancellaria bocageana Crosse and Debeaux, 1863: 77, pl. 9, fig. 3; Loebbecke, 1885: 41, pl. 13, figs 4–6.

Trigonaphera bocageana.—Habe, 1961: 436, pl. 24, fig. 11.

Description: Protoconch 2 smooth shining whorls, slightly depressed, merging gradually into adult sculpture. *Teleoconch* 5 convex whorls, body-whorl 65 per cent of total length. *Sutures* strongly impressed. *Sculpture* of strong, high rounded ribs, 10 to each whorl, crossed by multiple fine flat-topped threads and striations, scarcely raised, in turn crossed by multiple microscopic growth lines; tops of ribs are crossed by elongate white denticulations, with brown patches between,

about 14 on body-whorl, less noticeable on penultimate; ribs continue from edge of shoulders to sutures at an oblique angle. *Umbilicus* a narrow fissure behind inner-lip callus. *Aperture* trigonal, tapering to a short narrow open siphonal canal; a single tooth posteriorly; columella straight with 3 oblique plaits; inner-lip reflected on to body-whorl and over umbilical opening as a strong callus; outer-lip flared outwards, thin sharp edge, 8–12 lirations from near edge of lip extending well into aperture. *Colour* greyish-blue, ribs white with elongate brown cross markings, continued faintly across interstices; edge of aperture white, lirations and inner aperture greyish-blue or brown.

Type locality. "La mare des Indies".

Dimensions. Holotype, length 23·62 mm, breadth 14·25. Holotype is maximum length. Average size 20 mm x 12 mm.

Location of type. Museum d'Histoire Naturelle, Geneva, Reg'd No. 1097/86.

Distribution. Moreton Bay, southern Queensland (27° 50′ S., 153° 15′ E.), northwards along Queensland coast and into Gulf of Carpentaria, off Karumbah (17° 30′ S., 140° 44′ E.). Greatest depth recorded, 22–45 metres off Burnett Heads, Queensland (24° 45′ S., 152° 24′ E.). Mainly subtidal down to 45 metres. Widespread throughout Indonesia and Philippine Islands to Japan.

Material. Moreton Bay as above, 1 specimen, coll. H. T. Johnston, 1918, A.M. No. C. 75012. Off Karumbah as above, 2 specimens, coll. McMichael and Yaldwin, Dec. 1963, A.M. No. C. 73227. Greatest depth as above, 1 specimen, ex. N. Buckland coll., A.M. No. C. 90077.

A.M. 83 specimens (32 lots), N.M.V. 21 specimens (12 lots), S.A.M. 10 specimens (3 lots), Q.M. 7 specimens (4 lots), W.A.M. 2 specimens (1 lot), total 123 specimens (52 lots).

Discussion. The original description of this species stated "columella uniplicata", which is misleading, an enlarged colour photo of the holotype showing the specimen obviously to have been occupied by a hermit crab, resulting in the wearing away of the lower end of the columella and two plaits; the remaining plait is the one bordering the siphonal canal. The above photo has been carefully compared with a similar enlarged photo of the holotype of *Cancellaria costifera* Sowerby, and the two are conspecific beyond doubt. The latter specimen is held by B.M.N.H., Reg'd No. 1968405.

The species figured by Habe (1961a: pl. 24, fig. 7, and 1961b: pl. 36, fig. 6) as *Trigonostoma* (*Trigonaphera*) *costifera* Sowerby, has since been found to be an undescribed species and has been omitted from the synonymy.

The species named as *Cancellaria "bocageana"* Crosse and Debeaux is the pure white or very lightly coloured form of *Trigonostoma scalariformis* which occurs in the Gulf of Carpentaria amongst the more brightly coloured specimens, and also apparently in New Caledonia and Japan. The holotype of *Trigonostoma scalariformis* is one of the brightly coloured specimens so common in Queensland, especially on beaches near Bowen. The closest species to *Trigonostoma scalariformis* in general appearance is *T. scalarina* Lamarck, but as shown under "Discussion" following the description of that species it has a wider umbilicus, more spinose sculpture, and narrower and sharper axial ribs.

A most interesting observation has been conveyed to me personally by Mr Frank Plant of Queensland, who states that in August 1966 he observed at Queen's

Beach and Gray's Beach, Bowen, Queensland, half-grown specimens of *Trigonostoma scalariformis* attached to more than 50 per cent of the very numerous *Eucrassatella cumingi* A. Adams in the area. In all cases the *Trigonostoma scalariformis* were attached to the area close to where the siphon of the *Eucrassatella* would later be extended for the extraction of food from the sea-water, but the reason for this commensal habit is unknown.

Trigonostoma scalarina (Lamarck, 1822)

Figure 3, (14)

Cancellaria scalarina Lamarck, 1822: 113.—Deshayes, 1830: 189.—Kiener, 1841: 8, pl. 5, fig. 3.—Deshayes, 1843: 403.—Sowerby, 1849: 452, pl. 96, figs 87, 88 (non Lamarck, 1822).—Reeve, 1856: pl. 6, fig. 25 (non Lamarck, 1822).

Cancellaria crenifera Sowerby, 1832: 5, fig. 29; Sowerby, 1849: 453, pl. 96, figs 84–86; Reeve, 1856, pl. 6, fig. 24; Crosse, 1861: 230; Loebbecke, 1885: 9, pl. 1, figs 13–16; Tryon, 1885: 80, pl. 6, figs 97–99.

Cancellaria (*Trigonostoma*) *crenifera*.—Schepman, 1911: 264.

Scalptia crenifera; Habe, 1961: 436, pl. 23, fig. 7; pl. 24, fig. 4; Habe, 1964: 113, pl. 36, fig. 5; Kuroda, Habe and Oyama, 1971: 203, pl. 54, fig. 4.

Cancellaria thomasiana Crosse, 1861: 231; Loebbecke, 1885: 10, pl. 1, figs 17, 18; Tryon, 1885: 79, pl. 6, figs 92–94.

Cancellaria souverbiei Crosse, 1868: 272, pl. 9, fig. 5.

Description: Protoconch $2\frac{1}{2}$ smooth shining whorls, a little depressed, merging gradually into adult sculpture. *Teleoconch* $4\frac{1}{2}$ flatly convex whorls. *Sutures* strongly impressed. *Sculpture* of strong, high, sharp axial ribs, 10 to each whorl, crossed by fine transverse white striae, about 25 on body-whorl, 9 on penultimate, ribs sharply serrated at intersections; whorls sharply shouldered and turreted, ribs recurved and scaly on top of shoulders, continued as thin sharp ridges to sutures. *Umbilicus* small and deep, partly covered by inner-lip callus, ribs continued over base into opening. *Aperture* widely elongate, contracted both ends, a short open siphonal canal, toothed posteriorly; columella straight with 3 strong oblique plaits; inner-lip recurved as strong callus on to body-whorl; outer-lip flared outwards anteriorly, sharply edged, 10 lirations extend from near lip well into aperture. *Colour* white, purple-brown on top of shoulders, two broad brown or purple-brown bands round body-whorl, narrow white band between; lower brown band has a darker edge adjoining white section; lip of aperture white, brown blotching within.

Type locality. Seas of Isle-de-France.

Dimensions. Holotype, length 28·13 mm (marked on holotype as 27·5 mm). Holotype is maximum length. Average size 18 mm x 12 mm.

Location of type. Museum d'Histoire Naturelle, Geneva. Reg'd No. 1097/85.

Distribution. From 32 km N. of Delambre Island, Dampier Archipelago, northwestern Australia (20° 05′ S., 117° 06′ E.), across north of Continent in many localities, and south along Queensland coast to 77 metres (greatest depth recorded) off Moreton Bay (27° 22′ S., 153° 39′ E.). Subtidal to 77 metres. Widespread throughout the Indian Ocean, western Pacific Ocean and northwards to Japan.

Material. Delambre Island as above, 1 specimen, 41 metres, W.A.M. No. 565/71. Off Moreton Bay as above, 1 specimen, coll. W. F. Ponder, 29/3/69, H.M.A.S. *Kimbla*, A.M. No. C. 92793.

A.M. 230 specimens (44 lots), N.M.V. 103 specimens (21 lots), W.A.M. 17 specimens (7 lots), other 16 specimens (6 lots), total 366 specimens (78 lots).

Discussion: Tryon states (1885: 80) "*Cancellaria crenifera* and several other allied species are probably only varieties of *C. scalarina* Lamarck", also that "*C. scalarina* Sowerby (= *C. thomasiana* Crosse) is a variety of *C. scalarina* Lamarck", with which remarks I concur. Deshayes' detailed description of the species (1830: 189) identifies it well, and the later descriptions by Sowerby (1855: 452) and Reeve (1858: fig. 25) of *C. scalarina* Sowerby (= *C. thomasiana*) both agree with Deshayes' description. A number of specimens examined from Japan and Philippine Islands agree well with Australian specimens from the wide area of distribution shown above, only a few minor differences being apparent, all of which are variable and merge with those from other localities. Queensland specimens tend to have a darker background colour than those from most other areas. This species can be separated from *Trigonostoma scalariformis* Lamarck by its wider umbilicus, more spinose sculpture, and narrower and sharper axial ribs.

Trigonostoma tessella sp. nov.

Figure 3, (18)

Description: *Protoconch* 1½ smooth convex shining whorls, first half-whorl slightly deviated, ending abruptly at commencement of adult sculpture, nucleus submerged. *Teleoconch* 3½ whorls, flatly convex, contracted at base, strongly turreted and canaliculate, body-whorl 85 per cent of total length. *Sutures* strongly impressed at base of canal. *Sculpture* of strong, high, lamellate axial ribs, 17 on penultimate and body-whorl, crossed by strong transverse cords, high and rounded, giving shell a deeply pitted appearance; 4 of these cords on body-whorl, 3 on all others, situated between 3 or 4 closely packed smaller cords at top and bottom of each whorl; transverse cords are composed of 2 or 3 smaller cords tightly packed, and become broadly nodular at intersections with ribs; fine transverse threads and growth striae intersect in base of pits, giving a tessellated appearance under magnification. *Umbilicus* wide and deep, reaching to top of spire; axial ribs continue into aperture and are crossed by a number of striations. *Aperture* trigonal, columella straight, inner-lip curved outwards anteriorly, reflected over umbilical opening and on to body-whorl posteriorly; two weak plaits, centrally situated; outer-lip thin and slightly reflected; short open siphonal canal curved outwards; posterior end of aperture slightly depressed inwards. *Colour* pale chestnut with light brown band in centre of whorls, a further faint band towards base of body-whorl.

Type locality. Northeast of Cape Moreton, southern Queensland, (26° 47′ S., 153° 40′ E.), 114–124 metres.

Dimensions. Holotype, length 18·8 mm, breadth 14·3 mm. Very little variation in size of all specimens examined.

Location of type. A.M., Sydney, Reg'd No. C. 89285, ex. T. A. Garrard coll., together with 2 paratypes.

Distribution. From type locality southwards to Wooli, northern New South Wales (29° 42′ S., 153° 26′ E.), 109 metres, greatest depth recorded.

Material. Apart from holotype and 2 paratypes, 1 specimen from off Wooli as above, ex. T. A. Garrard coll., A.M. No. C. 89609. 1 specimen Moreton Bay,

southern Queensland (27° 17′ S., 153° 12′ E.), 1 km S. of Jumpin Pin Bar, 9 metres, July 1961, Univ. of Queensland, A.M. No. C. 67865. 1 specimen S. end of Stradbroke Island, southern Queensland (27° 50′ S., 153° 20′ E.), coll. Univ. of Queensland, 47–58 metres, A.M. No. C. 68719. 3 specimens off Moreton Bay, southern Queensland, H.M.A.S. *Kimbla*, coll. W. F. Ponder, 29/3/69, 77 metres, A.M. No. C. 77065. Total 9 specimens (5 lots), all A.M.

Discussion. This species is close to the African *Trigonostoma semidisjuncta* Sowerby, 1848, with the following exceptions; This new species has only 4 transverse cords on body-whorl and 3 in all others, in lieu of 6 and 5 respectively, these cords being between a solid band of fused smaller cords at top and bottom of each whorl; the transverse cords show no sign of bifurcation, which is common in *T. semidisjuncta*, and they also have an overlapping scaly form of growth, each new section being commenced behind and below the previous outer-lip; the protoconch in this new species is also higher and more prominent. with the typical deviated first whorl, common to many southern Australian species. It also has a slight resemblance to *T. amasia* Iredale, but is distinguished by the close-packed lamellate ribs and transverse cords, with deep pits between, also 2 weak columella plaits in lieu of 3 sharp plaits in *T. amasia*. *Trigonostoma semidisjuncta* Sowerby is recorded by Faustino (1928: 305) as occurring at Cagayan, Mindanao, P.I., but specimens are not available for study. The possibility cannot be overlooked that it may be this new species which has been misidentified as the South African shell.

Trigonostoma textilis (Kiener, 1841)

Figure 3, (1)

Cancellaria textilis Kiener, 1841: 10, pl. 7, fig. 1.—Sowerby, 1849: 455, pl. 93, fig. 34.—Reeve, 1856: pl. 6, fig. 28.—Loebbecke, 1885: 34, pl. 10, figs 5–8.

Scalptia textile Habe, 1961: pl. 24, fig. 19.

Description: Protoconch 1½ smooth, shining depressed whorls, merging gradually into adult sculpture. *Teleoconch* 5½ whorls, convex, strongly shouldered, canaliculate. *Sutures* impressed, sutural cavity becoming increasingly canaliculate with age. *Sculpture* of strong rounded axial ribs, about 10 on body-whorl, 12 on penultimate, several being in form of a varix at irregular intervals; ribs continue over shoulder, narrowing to a fine line at suture, nodular at top of shoulder; 10 main striae between shoulder of whorl and umbilicus on body-whorl, nodular on crossing ribs, scarcely visible between ribs; 5 striae on penultimate; 6 or 7 microscopic threads between each pair of main striae on body-whorl, 3 on penultimate; all striations crossed by microscopic growth lines. *Umbilicus* deep and very narrow; axial ribs cross umbilical ridge into opening as fine striations; inner-lip partly reflected over umbilicus. *Aperture* triangularly ovate, outer-lip thickened but with sharp reflected edge, 16 to 18 lirae within; inner-lip strongly recurved, partly over umbilicus; a short open siphonal canal inclined to left; columella straight with 3 plaits, posterior and central oblique; anterior horizontal. *Colour* light reddish-brown; main striae white on top of ribs, nodules on shoulders white; central main striation carries fine white hair-line round body-whorl and lower part of penultimate.

Type locality. Moluccas.

Dimensions. Holotype, length 24·75 mm. Average length 20 mm.

Location of type. Probably Museum d'Histoire Naturelle, Paris. Reg'd No. not available.

Distribution. 64 km W. of Cape Jaubert, Western Australia (18° 56′ S., 120° 56′ E.) and 23 km W. of Eaglehawk Island, Dampier Archipelago, Western Australia (20° 40′ S., 116° 27′ E.), only two Australian records. Also occurs over large area of western Pacific and northwards to Japan.

Material. Cape Jaubert as above, 1 specimen, 40 metres, W.A.M. No. 536-71. Eaglehawk Island as above, 1 specimen, 25 metres. W.A.M. No. 558-71. One further specimen examined from private collection, taken alive near Gaudalcanal, Solomon Islands; this specimen has first whorls a deep leaden-grey and body-whorl jet black, but with usual white tips on nodules.

Discussion. Compared with *T. scalata* Sowerby (not recorded from Australian waters) this species has white-tipped nodules without the accompanying brown flecks in *T. scalata*, and 10–11 axial ribs on body-whorl as against 19–20; it is also a smaller shell, and the body-whorl is about 52 per cent of total length compared with 62 per cent in *T. scalata;* it also has a wider umbilicus and a shallower canal at the suture.

Trigonostoma vinnula Iredale, 1925

Figure 3, (5) and (6)

Trigonostoma vinnulum Iredale, 1925: 263, pl. 43, fig. 18.

Trigonaphera vinnulum.—Iredale, 1936: 319.—Laseron, 1955: 270, fig. 8 (vinnula).

Description: Protoconch prominent, of 1½ smooth shining convex whorls, first half-whorl deviated, nucleus well submerged. *Teleoconch* 4½ convex, coronate, flatly shouldered whorls. *Sutures* deeply impressed. *Sculpture* of strong, rounded oblique axial ribs, 9 on body-whorl and penultimate, coronate at top of shoulders, and crossing flat space to sutures obliquely; ribs crossed by 9 fine transverse striae on body-whorl, 4 on penultimate, with a microscopic thread between each pair, whole sculpture crossed by microscopic growth lines. *Umbilicus* small and deep, partly covered by inner-lip callus. *Aperture* ovate, posterior end truncate, a short broad open siphonal canal; columella straight with 3 strong oblique plaits; inner-lip recurved as strong callus on to body-whorl; outer-lip regularly curved, sharp-edged and flared outwards; 10 lirations commence below edge of outer-lip and extend well into aperture. *Colour* fawn to light brown, with narrow white band round centre of body-whorl.

Type locality. Off Twofold Bay, New South Wales (37° 03′ S., 150° 03′ E.), 45 metres.

Dimensions. Holotype, length 12·5 mm, breadth 7 mm. Normal size. Largest specimen examined 18 mm x 12 mm.

Location of type. A.M. Sydney, Reg'd No. C. 53774.

Distribution. 73 metres off Redhead, New South Wales (32° 57′ S., 151° 45′ E.), southwards to Twofold Bay, N.S.W. (37° 04′ S., 149° 56′ E.), 27 metres. Greatest depth recorded, 73 metres off Redhead as above. Appears to be confined to moderate depths, seldom seen on beaches.

Material. Off Redhead as above, 19 km S. of Newcastle, 1 specimen, coll. T. Iredale, July, 1939, A.M. No. C. 89757. Twofold Bay as above, 1 specimen, ex. N. Buckland coll., A.M. No. C. 89758. A.M. 26 specimens (5 lots), other museums 5 specimens (4 lots), total 31 specimens (9 lots).

Discussion. The closest congener to this species is *T. diamantina* nov., described in this revision from Western Australia. The only species within its range with which collectors could confuse *T. vinnula* is *Trigonostoma bicolor* (Hinds), stunted specimens of which occur in central New South Wales, formerly known as *Trigonaphera interlaevis* Laseron; these can be readily separated by their much larger umbilicus, and even though the red-brown band may be absent round body-whorl, the brown patches are usually present in the concave spaces on top of shoulders between ribs.

Genus *Admetula* Cossmann, 1889: 228. Type species by original designation *Cancellaria evulsa* (Solander, 1766)

References: Wenz, 1938–44: 1369.

Diagnosis: Shell small and broad, numerous axial ribs, up to seven varices, crossed by fine but strong spiral striae with finer threads between; aperture broadly ovate, columella with three strong plaits, anterior canal narrow and recurved.

Admetula garrardi Petit, 1974

Figure 2, (10)

Cancellaria (*Merica*) *nassoides* Schepman, 1911: 263, pl. 18, fig. 9.

Neadmete nassoides.—Habe, 1961: 435, pl. 23, fig. 5.

Admetula garrardi Petit, 1974: 109, text fig. 1 (new name for *Cancellaria nassoides* Schepman, 1911, not *Cancellaria nassoides* von Koenen, 1889: 149).

Description: Protoconch 1½ smooth, shining, deviated whorls, merging gradually into main whorls, nucleus well submerged. *Teleoconch* 6 globose strongly ribbed whorls. *Sutures* strongly impressed. *Sculpture* of strong rounded oblique axial ribs, 14–17 on body-whorl and penultimate, crossed by strong spiral lirae, 9 on body-whorl with 8 intermediate, 4 main lirae and 5 intermediate on penultimate, elongate lateral nodules at points of crossing with ribs; whole sculpture crossed by extremely fine growth lines; usually 6–7 varices present. *Umbilicus* nil. *Aperture* small and ovate, a short broad open siphonal canal; columella straight with 3 strong oblique plaits; inner-lip a light glaze on to body-whorl; outer-lip regularly curved, thin and crenulate, 7 lirations extending well into aperture. *Colour* light olive-brown on first whorls, fawn body-whorl; thin hirsute fawn periostracum.

Type locality. Near Kei Islands, 397 metres (5° 26′ 6″ S., 132° 32′ 5″ E.) South of western end of West Irian—now known as Ewab Islands.

Dimensions. Holotype, length 16·5 mm, breadth 10 mm. This is apparently average adult size.

Location of type. Amsterdam Museum, Netherlands, Reg'd No. unknown.

Distribution. Recorded in Australia only from N.N.E. of Cape Moreton, southern Queensland (26° 48′ S., 153° 35′ E.), 114–124 metres. Extends northwards as far as Japan.

Material. 8 immature specimens from off Cape Moreton as above, ex. T. A. Garrard coll., obtained from trawler. A.M. No. C. 89279.

Discussion. Without close inspection the above small specimens could be confused with immature *Trigonostoma amasia* Iredale, but lack the square-cut shoulders, and the much bolder ribs and numerous varices are a distinguishing feature.

Note: The group dealt with from hereon (subfamily Admetinae of Cossmann, 1899) contains many small species, nearly all from temperate to cold regions and from deep to very deep water, all apparently lacking a radula and mostly without colour, being off-white to greyish-white. The columella is sometimes arcuate instead of straight, some completely lack columella plications, in others which have one or possibly two plications, these are mostly very weak or barely visible, and a variable feature.

Genus *Bonellitia* Jousseaume, 1887

Bonellitia Jousseaume, 1887, *Le Naturaliste* (2) 9: 225. Type species by original designation *Cancellaria bonelli* Bellardi.

References: Finlay, 1930: 240; Marwick, 1931: 120; Wenz, 1938–44: 1369.

Diagnosis: Shells very small, four convex main whorls, sharp oblique axial ribs crossed by strong transverse striae, sharply nodulose at intersections; no umbilicus; aperture broad, tapering either end; body-whorl usually 75 per cent of total length; columella straight, with 3 medium oblique plaits.

Bonellitia scobina (Hedley and Petterd, 1906)

Figure 2, (11)

Cancellaria scobina Hedley and Petterd, 1906: 222, pl. 38, fig. 12; Hedley, 1907: 360, Iredale, 1925: 265.

Sydaphera scobina; Laseron, 1955: 270.

Description: Protoconch 1¼ smooth, opaque, light-grey rounded whorls, first half-whorl deviated, ending abruptly at commencement of adult whorls, nucleus submerged. *Teleoconch* 3½ convex whorls, strongly shouldered, concave shelf at top, contracted at base. *Sutures* well impressed. *Sculpture*—weak curved axial riblets on all whorls, 16 to whorl, crossing shoulders and continuing obliquely almost to sutures; ribs are crossed by strong flat-topped cords, 9 on body-whorl, 5 on penultimate, nodular at intersections; one or two weaker striae between cords; 5 or 6 weak striae between shoulder and suture. *Umbilicus* a minute fissure behind inner-lip callus. *Aperture* broad, contracted either end; outer-lip thickened and curved, finely lirate within; inner-lip reflected as strong callus on to body-whorl; columella straight, 3 medium plaits, posterior and central strongly oblique, anterior slightly so; siphonal canal short, broad and open. *Colour* light grey.

Type locality. Off Sydney, New South Wales (33° 55′ S., 151° 42′ E.), 549 metres.

Dimensions. Holotype, length 8 mm, breadth 5 mm.

Location of type. A.M., Sydney, Reg'd No. C. 24448.

Distribution. Type locality only.

Material. Holotype is unique. Pres. by authors.

Discussion. Hedley stated (1907: 360) that he had compared a specimen of this species from 80 fathoms (146 metres) off Narrabeen, New South Wales, with the holotype of *Cancellaria micra* Tate in the University Museum, Adelaide. He stated that the fossil had more and finer spirals, but weaker radials, and that in other respects they were identical. Attached to the glass tablet in the A.M. are two glass tubes, one containing the holotype and the other an immature specimen, purporting to be the same species, from 250 fathoms (457 metres) off Sydney (Hedley, 1906: 223). On examination this proves to be an immature specimen of *Gergovia exigua* E. A. Smith, whilst the other specimen referred to above from 146 metres off Narrabeen, and compared with the holotype of *C. micra* Tate, is one of 6 presented to the A.M. in 1907 by Prof. Haswell, and a new species named in this revision. This new species is certainly far closer to *C. micra* than it is to *Bonellitia scobina* or *Gergovia exigua.*

Genus *Gergovia* Cossmann, 1899

Gergovia Cossmann, 1899: 16. Type species by original designation *Cancellaria platypleura* Tate (= *Cancellaria laticostata* Tenison-Woods, 1879. Invalid name change).

References: Wenz, 1938–44: 1358.

Synonyms: Microsveltia Iredale, 1925. Type species by monotypy *Microsveltia recessa* Iredale, 1925. *Gergovia laticostata* Tenison-Woods, type for the genus *Gergovia*, is so close to *Microsveltia recessa* Iredale, that the former was almost certainly ancestral, and the introduction of a further genus was unwarranted.

Diagnosis: Shell very small, strongly and boldly ribbed, coronate and canaliculate, strong flat-topped transverse striae, prominent deviated protoconch, small ovate aperture, columella straight, two medium to strong plaits.

Gergovia exigua (E. A. Smith, 1891)

Figure 4, (1)

Cancellaria exigua E. A. Smith, 1891: 439, pl. 34, fig. 11.—Iredale, 1925: 265.

Description: Protoconch $1\frac{1}{2}$ smooth white, shining, deviated whorls, merging gradually into sculpture of main whorls, nucleus submerged. *Teleoconch* $3\frac{1}{2}$ flatly convex whorls, doubly angled by cross striae, constricted top and bottom. *Sutures* strongly impressed. *Sculpture* of strong raised axial ribs, 10 on body-whorl and penultimate, crossed by prominent striae, 8 on body-whorl, main two strongly nodular at intersections, the whorls crossed by numerous microscopic growth lines. *Umbilicus* a fine fissure behind inner-lip callus. *Aperture* oval, short broad open siphonal canal; columella arcuate, two oblique plaits, lower forming edge of canal; inner-lip reflected as glazed callus, partly over umbilical fissure; outer-lip regularly curved, thin, and crenulated by cords, which show as grooved channels interiorly. *Colour* off-white.

Type locality. Off Sydney, New South Wales (33° 55′ S., 151° 28′ E.), 750 metres (Disputed "Challenger" station 164B).

Dimensions. Holotype, length 6 mm, breadth 3 mm. Normal size.

Location of type. B.M.N.H. Reg'd No. 1889.10.12.16.

Distribution. Caloundra, Queensland (26° 47′ S., 153° 02′ E.), southwards along N.S.W. and Victorian coast to 118 metres E. of Babel Island, Bass Strait

(39° 26′ S., 147° 23′ E.). Greatest depth recorded, 1 463 metres E. of Sydney (33° 55′ S., 151° 41′ E.). The single specimen from Caloundra above was beach collected, which is out of keeping with the depths recorded for all other specimens. The most likely explanation is that the specimen was washed overboard from the deck of a trawler on return to port and then on to the nearby beach. Inhabits deep to very deep water. Eastern Australian coast only.

Material. Caloundra as above, 1 specimen, ex. J. Kerslake coll. A.M. Reg'd No. C. 89288. E. of Babel Island as above, 1 specimen, 118 metres, ex. T. A. Garrard coll. A.M. No. C. 89290. Greatest depth as above, 2 specimens, 56 km E. of Sydney, coll. Prof. Haswell, *c.* 1914. A.M. No. C. 26676-7. A.M. 23 specimens (7 lots). N.M.V. 1 specimen, 118 metres off Cape Everard, No. F. 20842.

Discussion. This very small species has proved to be widespread in greatly varying depths of water. Once studied under magnification it can be recognized on sight by the widely spaced ribs crossed by the two prominent centrally situated striations which bi-angulate the whorls, forming sharp nodules at points of crossing. Although the sculpture is not so bold and prominent as that of *Gergovia recessa*, it has the same general pattern with spirals over-riding the axial ribs and forming the same sharp elongate nodules at point of crossing; also 2 strong plaits, identical protoconch, and similar aperture.

Gergovia haswelli sp. nov.

Figure 4, (7)

Description: Protoconch $1\frac{1}{2}$ smooth, convex, translucent-white whorls, first half-whorl deviated, merging gradually into main whorls, nucleus submerged. *Teleoconch* $3\frac{1}{2}$ convex whorls, flatly shouldered, sharply contracted at base. *Sutures* deeply impressed. *Sculpture* of strong rounded axial ribs, 9 on body-whorl and penultimate, crossed by strong transverse striae, 3 on first whorl, increasing to 6 or 7 on penultimate, and about 12 on body-whorl, with one or two fine intermediate threads near periphery; cross striae are a little thickened at intersections with ribs, some gemmate on early whorls; whole sculpture is crossed by microscopic growth lines. *Umbilicus*—a very fine fissure usually present. *Aperture* widely elongate, regularly rounded posteriorly, slightly produced anteriorly into a broad open siphonal canal; columella straight, one slight central plait visible in some specimens, two in others, usually showing more strongly at rear of columella; inner-lip recurved as a strong glaze on to body-whorl; outer-lip regularly curved, thickened but sharp-edged, crenulate, 4 or 5 very weak internal lirae in some specimens. *Colour* off-white.

Type locality. 35 km E. of Narrabeen, New South Wales (33° 45′ S., 151° 44′ E.), 146 metres.

Dimensions. Holotype, length 3·8 mm, breadth 1·9 mm. Average size.

Location of type. A.M., Sydney, Reg'd No. C. 25843.

Distribution. From type locality southwards to 48 km S. of Cape Everard, Victoria (37° 17′ S., 149° 47′ E.). Lowest depth recorded, 366 metres, Cape Everard as above. Apparently confined to deep water.

Material. Type series contains holotype and 5 paratypes, coll. Prof. Haswell, 2/1/1907. Off Cape Everard as above, 4 specimens ,"Endeavour", 22/10/1914, A.M. No. C. 89292. 1 specimen 43 km S. x E. of Cape Everard, 165–274 metres, "Endeavour", 9/5/1914, A.M. No. C. 89293.

Total A.M. 11 specimens (3 lots).

Discussion. This is the species referred to by Hedley (1907: 360) which he compared with the holotype of the Tertiary fossil *Cancellaria micra* Tate, then at the University Museum, Adelaide (see "Discussion" under *Bonellitia scobina* Hedley and Petterd). Enlarged drawings of two of the three type series of *C. micra* forwarded by Dr H. Laws from S.A.M. show the finer spirals and weaker radials as stated by Hedley, otherwise the resemblance of this new species to the fossil is strong.

Gergovia haswelli can be distinguished from *G. exigua* by its much smaller size and more numerous transverse striae, about 7 on penultimate whorl, compared with the 2 bold and prominent transverse striae which biangulate all whorls in *G. exigua*. It can also be separated from *G. recessa* by its smaller size and more numerous, finer transverse cords, whilst *G. recessa* has much bolder ribbing, crossed by two prominent transverse cords on each whorl, with finer cords above, below and between.

Gergovia recessa (Iredale, 1925)

Figure 3, (7) and (8)

Microsveltia recessa Iredale 1925: 265, pl. 43, fig. 16; Laseron, 1955: 271, fig. 11.

Description: Protoconch $1\frac{1}{2}$ whorls, tall and prominent, first half-whorl deviated, smooth and shining, nucleus submerged. *Teleoconch* $4\frac{1}{2}$ strongly bi-carinate convex whorls, turreted and slightly canaliculate. *Sutures* deeply impressed. *Sculpture* of very heavy prominent rounded axial ribs, 9 to each whorl, crossed by two bold and prominent narrow cords on each whorl, two additional towards base of body-whorl; cords form prominent lateral nodules at junction with ribs; one fine sharp striation below each cord, 2 on body-whorl below lower cord; 5 larger striae cross ribs and interstices on top of shoulders on body-whorl, four on penultimate and 3 on next whorl; a further 8 fine wavy striations at base of body-whorl; entire sculpture is covered by microscopic hair-like growth lines. *Umbilicus* small and narrow, partly covered by inner-lip callus. *Aperture* ovate, a short wide open siphonal canal; columella straight, 2 strong slightly oblique plaits; inner-lip recurved on to body-whorl as a strong callus; outer-lip regularly curved, 4 deep indentations from below shoulder to base caused by external cords; 8 strong lirations below edge of outer-lip extend well into aperture, with extremely fine hair-lines between. *Colour* bright chestnut; fine bristly greenish-brown periostracum.

Type locality. Off Bateman's Bay, New South Wales (35° 45′ S., 150° 29′ E.), 137 metres.

Dimensions. Holotype, length 6 mm, breadth 3·5 mm. Maximum length 7·5 mm.

Location of type. A.M. Sydney, Reg'd No. C. 53771.

Distribution. Off Crowdy Head, N.S.W. (31° 50′ S., 152° 39′ E.), southwards to Twofold Bay, N.S.W. (37° 05′ S., 150° E.). Lowest depth recorded, 82–100 metres for specimen from off Crowdy Head, shallowest depth 18 metres in Twofold Bay.

Material. Apart from holotype, only 5 specimens are held in A.M., Sydney, and none by other Museums. 82–100 metres off Crowdy Head as above, ex. T. A. Garrard coll., A.M. Reg'd No. C. 90150. 128–146 metres off Cape Everard, Vic. 2 specimens, coll. T. Iredale, A.M. No. C. 94707. 18 metres in Twofold Bay, ex.

T. A. Garrard coll., A.M. No. C. 90151. 82 metres off Twofold Bay, coll. T. Iredale, A.M. No. C. 90152.

Discussion. This species is probably a direct descendant of the Victorian Tertiary fossil *Gergovia laticostata* Tenison-Woods, type for the genus, which it closely resembles. A most interesting comparison of *G. laticostata* and *G. recessa* with specimens of the larger *Agatrix agassizi* Dall, 1889, from the west coast of Florida, U.S.A., shows such a strong resemblance that a close relationship would appear to exist, despite the great distance between localities. The protoconch is identical, also the bold type of axial ribbing and cross striations, the strongly coronate shoulders and slight canal at the sutures, even in one specimen of *G. recessa* the remnants of tufted nodes of periostracum on top of the shoulders, referred to by Petit (1967: 218). The main point of difference apart from size is the existence of 3 columella plaits in *Agatrix agassizi* compared with only two in *G. recessa*.

Genus *Inglisella* Finlay, 1924

Inglisella Finlay, 1924: 513. Type species by original designation *Ptychatractus pukeuriensis* Suter, 1917.

References: Finlay, 1930: 240; Marwick, 1965: 41; Wenz, 1938–44: 1364.

Synonyms: Nil.

Diagnosis: Shell very small, elongate-ovate, four main whorls, strongly axially ribbed, heavy flared outer-lip, two small columella plaits, tall 2 whorled regular protoconch.

Inglisella etheridgei (Johnston, 1880)

Figure 4, (2)

Cancellaria etheridgei Johnston, 1880: 32.—Tate, 1889: 157; pl. 9, fig. 6.

Description: Protoconch large, smooth, $1\frac{1}{2}$ or 2 convex whorls, first half-whorl deviated, merging gradually into adult sculpture, nucleus submerged. *Teleoconch* $4\frac{1}{2}$ convex whorls, strongly ribbed. *Sutures* deeply impressed. *Sculpture* of strong, broadly rounded axial ribs, 10 on penultimate, tending to fade on body-whorl, and terminating a little below periphery; ribs crossed by strong flat-topped transverse striae, 12–14 on body-whorl, 4–5 on penultimate, all crossed by microscopic growth lines. *Umbilicus* nil. *Aperture* ovate, broadly rounded posteriorly, a short wide siphonal canal anteriorly, 2 small faint centrally situated plaits; inner-lip strongly reflected on to body-whorl, peritreme entire; outer-lip regularly curved, strongly thickened but sharp-edged, flared outwards, 6 strong internal lirae. *Colour* off-white.

Type locality. Fossil Bluff, Table Cape, near Wynyard, N.W. Tasmania. Table Cape Group: Longfordian: Lower Miocene.

Dimensions. Holotype, length 7 mm, breadth 3 mm. This appears to be maximum size.

Location of type. Tasmanian Museum, Hobart. Mislaid at present time.

Material. 4 fossil topotypes, Q.V.M., Launceston, Reg'd No. 1957: 38: 222. 2 fossil topotypes ex. T. A. Garrard coll., A.M. No. C. 89270.

2 recent specimens, 48 km S. of Cape Everard, Victoria, 366 metres, "Endeavour", 22/10/1914, A.M. No. C. 89271 (37° 17′ S., 149° 47′ E.).

Distribution. Type locality for fossil specimens, and only locality noted above for Recent specimens.

Discussion. The only differences between the two Recent specimens above and fossil specimens is that in the fossils the transverse striae commence a little lower down the whorls, leaving a clear space below the sutures, the sutures are not quite so deeply impressed, and the columella plaits are a little stronger. These small differences are insufficient to warrant separation, especially as only two Recent specimens are known, and also in view of their eroded condition. This species is almost identical with the New Zealand fossil species *Inglisella pukeuriensis* Suter, type for the genus, except for the deviated protoconch in *I. etheridgei.*

Inglisella fischeri (A. Adams, 1860)

Figure 4, (8)–(11)

Cancellaria (*Merica*) *fischeri* A. Adams, 1860: 411.

Description: Protoconch large, white and shining, $1\frac{1}{2}$ whorls, first half-whorl deviated, merging gradually into adult sculpture, nucleus well submerged. *Teleoconch* $3\frac{1}{2}$ whorls, roundly convex, angulate at sutures. *Sutures* well impressed. *Sculpture* of flatly rounded axial ribs, 8 on penultimate, tending to fade on body-whorl, crossed by thin transverse striae, usually 7 on body-whorl, tending to disappear towards base, 3 on other whorls, all crossed by microscopic growth lines. *Umbilicus* a fine fissure behind inner-lip callus. *Aperture* broad, tapering a little either end; columella arcuate, two weak slightly oblique plaits, with a third fold on edge of short, broad open siphonal canal; inner-lip strongly calloused on to body-whorl, inclined to left anteriorly; outer-lip uniformly curved, thickened, flared outwards anteriorly, 8 or 9 lirations extending well into aperture. *Colour* uniformly chalky-white, possibly translucent when alive.

Type locality. "Strait of Corea" (35° N., 130° E.), 114 metres.

Dimensions. Three syntypes, B.M.N.H., Reg'd No. 1968419:

(1) length 6·9 mm, breadth 3·8 mm.

(2) length 6·5 mm, breadth 3·3 mm.

(3) length 7·2 mm, breadth 3·4 mm.

Location of type. Three syntypes as above.

Distribution. Only two localities recorded in Australia are: South of Cape Catastrophe, South Australia (35° 45′ S., 135° 52′ E.), and between Eucla and Esperance, Western Australia (32° to 35° S., 121° 30′ to 129° E.).

Material. 4 specimens from S. of Cape Catastrophe, 114 metres, ex. T. A. Garrard coll., A.M. No. C. 89273. 4 specimens between Eucla and Esperance, 79–147 metres, coll. CSIRO, H.M.A.S. *Gascoyne*, G2/96-97/62, 5–9/7/1962. A.M. No. C. 89291. One specimen of this series donated to D.S.I.R., New Zealand Geological Survey Branch, Lower Hutt, New Zealand, in World Mollusca collection, cat. No. WM. 11,253.

Discussion. The above 8 specimens have all been compared with enlarged photographs of the 3 syntypes of *Cancellaria* (*Merica*) *fischeri* A. Adams, forwarded by courtesy of B.M.N.H. It is found that two or three very minor differences exist between the three syntypes, between the 8 specimens now held, and between these

specimens and the syntypes. These slight differences are only variable features common to other species in the group, and for the present the two populations can be considered conspecific. A note with the syntypes in B.M.N.H. states "Adams does not mention the source of his material". The type locality "Strait of Corea" has possibly been nominated by another worker at a later date, although the title of Adams' paper was "On some genera and species of shells from Japan".

Inglisella nympha sp. nov.

Figure 4, (14)

Description: Protoconch large and prominent, $1\frac{1}{2}$ transparent shining deviated whorls, terminating abruptly at adult sculpture, nucleus slightly submerged. *Teleoconch* 3 translucent, convex, bi-carinated whorls, body-whorl 60 per cent of total length. *Sutures* strongly impressed. *Sculpture* of two fine sharp transverse threads, bi-carinating whorls, a third thread on body-whorl at suture line; heavy growth lines, simulating narrow axial ribs, occur at irregular intervals, conforming to shape of outer-lip; commencing at third thread near suture line, and crossing a further vague flattened thread below it, occur a multitude of very fine sharp crowded growth lines extending to base of shell; these lines are completely absent above the third thread, where only a few finer growth lines occur spasmodically between the much heavier pseudo "ribs". *Umbilicus* absent. *Aperture* widely ovate, tapering sharply posteriorly, opening anteriorly into a short broad siphonal canal, inclined to left under columella; columella arcuate, one very weak flattened central ridge hehind columella, inner-lip not calloused; outer-lip thin and regularly curved. *Colour* translucent off-white.

Type locality. 53 km E. × S. of Green Cape, New South Wales (37° 18′ S. 150° 34′ E.), 860 metres.

Dimensions. Holotype, length 6·6 mm, breadth 3·2 mm. Apparently mature.

Location of type. A.M., Sydney Reg'd No. C. 89280.

Distribution. Type locality, and 61 km S. of Tamboon Inlet, Victoria, off Gippsland coast (38° 24′ S., 149° 08′ 50″ E.), 987 metres.

Material. Holotype coll. "Endeavour", 2/10/1912. Off Tamboon Inlet as above, 2 immature paratypes coll. C. Phipps, "Esso-Gipps", May, 1969, in ooze, Stn. 3. A.M. No. C. 94706.

Discussion. Compared with *Inglisella fischeri* A. Adams, this species has a protoconch twice the size, less transverse striations, no axial ribbing, the aperture widens out considerably more anteriorly, it has no internal lirae, and only one barely discernible columella plait; it is also a thinner and frailer shell. Fortunately the holotype and larger paratype are in fine condition.

Genus *Pepta* Iredale, 1925

Pepta Iredale, 1925: 266. Type species by monotypy *Admete stricta* Hedley, 1907

References: Wenz, 1938–44: 1371.

Synonyms: Pallidonia Laseron, 1955. Type species *Pallidonia simplex* Laseron, 1955. The general whorl formation, shape of aperture, over-riding spiral sculpture and axially ribbed protoconchs show too close a relationship between

Pepta stricta, type for the genus, and *P. simplex* to warrant separation in another genus.

Diagnosis: Shell very small, four convex main whorls, ribs over-ridden by strong spiral cords, lunate aperture, axially ribbed protoconch, no columella plaits, off-white translucent or opaque.

Pepta stricta (Hedley, 1907)

Figure 4, (5)

Admete stricta Hedley, 1907: 295, pl. 54, fig. 10.

Pepta stricta; Iredale; 1925: 266; Laseron, 1955: 272, fig. 12.

Description: Protoconch 2 convex translucent whorls, obliquely closely axially ribbed, 15 to whorl, commencing at nucleus, which is submerged, 8 fine transverse striae between ribs, sculpture merging gradually into that of main whorls. *Teleoconch* 4 whorls, convex, periphery above centre, slightly quadrate in form. *Sutures* strongly impressed. *Sculpture*—whorls moderately to strongly axially ribbed, 14 on penultimate and body-whorl, crossed by strong transverse flat-topped striae, 6–7 on penultimate, 13 on body-whorl, slightly nodular in places at intersections with ribs, interstices a little broader than striae; microscopic growth lines cross both transverse striations and interstices. *Umbilicus* a very fine fissure behind inner-lip callus. *Aperture* broadly and roundly lunate; inner-lip reflected anteriorly on to body-whorl, a light glaze posteriorly; columella slightly arcuate, devoid of folds; outer-lip thin, regularly curved, crenulated exteriorly by striae; siphonal canal short, broad and open. *Colour* off-white, opaque.

Type locality. 35 km E. of Narrabeen, New South Wales (33° 45′ S., 151° 33′ E.), 146 metres.

Dimensions. Holotype, length 4·5 mm, breadth 1·76 mm. Fully grown.

Location of type. A.M., Sydney, Reg'd No. C. 25771.

Distribution. From 3 km N.E. of W. side of Gillett Cay, Swain Reefs, Queensland, (21° 43′ S., 152° 25′ E.), southwards along Queensland coast and New South Wales, thence westwards to Wilson's Bluff, Western Australia, (33° 05′ S., 128° 40′ E.) in depths from 63 to 183 metres.

Material. Apart from holotype, other specimens are as follows:

1 specimen, Gillett Cay as above, 63–73 metres, coll. A.M. party, 17–19 Oct., 1962, A.M. No. C. 92919.

1 specimen, 26 km E. of Wollongong, N.S.W. (34° 21′ S., 151° E.), 183 metres (greatest depth), coll. C. Hedley, A.M. No. C. 25812.

1 specimen, 161 km S. × W. of Wilson's Bluff, Western Australia, as above, 75 metres, coll. CSIRO, H.M.A.S. *Gascoyne*, G2/97/62, 5/7/1962, A.M. No. C. 89295.

Discussion. The above specimen from off Wilson's Bluff, W.A., has 5 transverse striae in lieu of 7 on penultimate whorl, axial ribs are less pronounced than in holotype, and incremental growth lines are very clear and prominent in interstices between transverse striations.

Pepta simplex (Laseron, 1955)

Figure 4, (6)

Pallidonia simplex Laseron, 1955: 272, fig. 13.

Description: *Protoconch* 2 convex whorls, dome shaped, translucent, nucleus submerged, fine microscopic axial plications faintly visible, commencing close to nucleus. *Teleoconch* 3 whorls, convex, body-whorl more than half length of shell. *Sutures* impressed, at base of fine narrow canal. *Sculpture*—whorls carry very weak, broad rounded axial ribs, 10 to whorl, over-ridden by strong flat-topped striae, 7 on penultimate, 15 on body-whorl, interstices equal in width to striae, one varix present on penultimate whorl in type. *Umbilicus* nil. *Aperture* widely ovate; outer-lip thin with broad very shallow subsutural sinus, and crenulated exteriorly by striae; columella slightly arcuate, devoid of plaits; inner-lip reflected on to body-whorl as light glaze; anterior end of aperture a widely curved continuation of outer-lip. *Colour* off-white.

Type locality. Off Point Halliday, New South Wales (32° 02′ S., 152° 36′ E.), 14–18 metres.

Dimensions. Holotype, length 3·9 mm, breadth 1·7 mm.

Location of type. A.M., Sydney, Reg'd No. C. 80101.

Distribution. Type locality only.

Material. Holotype is unique. Pres. C. F. Laseron.

Discussion. The holotype is slightly worn, but the faintly visible axial plications commencing immediately after the protoconch nucleus, and with a similar protoconch to *Pepta stricta* Hedley, show its close affinity to that species. The outer-lip is slightly chipped and worn, but traces of a broad and very shallow subsutural sinus are present behind the lip, as stated by the author, but this does not appear to have any special significance.

Genus *Vercomaris* nov.

Vercomaris gen. nov. Type species here designated *Cancellaria pergradata* Verco, 1904.

Diagnosis: Shell very small, squarely turreted and coronate, flatly canaliculate; transversely sculptured with heavy cords crossing weak riblets, nodular at points of crossing; aperture elongate ovate, siphonal canal short, open and broad; columella two or three plaited; protoconch prominent, first half-whorl deviated, nucleus submerged; umbilicus negligible or absent.

The closest existing genus to *Vercomaris* nov. is probably *Oamaruia* Finlay, 1924 (Type *Admete suteri* Marshall and Murdoch). However in this new genus the whorls are coronate and flatly canaliculate, in *Oamaruia* the whorls slope downwards from the suture to the shoulder; in *Vercomaris* the spirals are strongly predominant, the axials in many specimens of *V. pergradata* being merely fine filaments in the interstices or missing altogether; in *Oamaruia* the axials and spirals are of approximately equal strength and sharply nodular at points of intersection. The aperture in *V. pergradata* is widely ovate, the anterior canal being very wide and open and flared outwards, whilst in *O. suteri* the aperture is narrowly ovate, contracted anteriorly into a narrower and more elongate canal.

Vercomaris pergradata (Verco, 1904)

Figure 3, (2)

Cancellaria pergradata Verco, 1904: 142, pl. 26, fig. 19.

Oamaruia pergradata; Cotton and Godfrey, 1932: 55, pl. 3, fig. 5.

Oamaruia pergradata profundior Cotton and Godfrey, 1932: 55, not fig'd.

Description: Protoconch $1\frac{1}{2}$ smooth, shining, deviated, flatly convex whorls, finishing abruptly at commencement of first main whorl, nucleus well submerged. *Teleoconch* $4\frac{1}{2}$ flatly convex whorls, constricted at base, strongly shouldered, flatly canaliculate. *Sutures* strongly impressed. *Sculpture* of strong, flat-topped transverse cords, 3 on first main whorl, 4 on next two, 8 on body-whorl; cords become axially denticulate in crossing thin, sharp axial riblets, situated well below top of cords, 20 to each whorl; between each pair of riblets are about 10 microscopic growth lines; a further strong coronate cord lies at the angle of each whorl, with a smaller tuberculate cord between it and the suture; riblets cross the flatly canaliculate area to the suture at an oblique angle. *Umbilicus* absent. *Aperture* elongate, medium width, columella recurved to left anteriorly, with two strong broadly rounded plaits; inner-lip forms a thin glaze on to body-whorl; outer-lip regularly curved, crenulate, flared outwards anteriorly, with short broad notched siphonal canal; short wide indentations in outer-lip behind each external cord, no internal lirae. *Colour*—sculpture light chestnut, darker brown colour shows through from interior in pits between cords and riblets.

Type locality. Gulf St Vincent, South Australia (centre 35° S., 138° E.), 30 metres.

Dimensions. Holotype, length 10 mm, breadth 5 mm. Normal size.

Location of type. S.A.M., Adelaide, Reg'd No. D. 13518.

Distribution. Cape Borda, Kangaroo Island, South Australia (35° 45′ S., 136° 33′ E.), eastwards and north to Narrabeen, New South Wales (33° 45′ S., 151° 44′ E.), and including Tasmania.

Material. Apart from holotype, 11 specimens held by S.A.M. Reg'd No. D. 10175, from 36, 73 and 274 metres off Beachport (37° 30′ S., 140° E.), and 100 metres off Cape Borda, South Australia, all in one container . One paratype held by A.M. from type locality, pres. by Sir Jos. Verco (author), Reg'd No. C. 19969, and one immature specimen from 64 km S. of Cape Wiles, South Australia, 183 metres, "Endeavour", August, 1909, No. E. 4101. One specimen 35 km E. of Narrabeen, N.S.W., 146 metres, pres. Prof. Haswell, 2/1/1907, A.M. No. C. 25778 (body-whorl only). One specimen, A.M. No. C. 90606, 113 metres N. of Cape Lodi, Eastern Tasmania (41° 45′ 30″ S., 148° 31′ E.), coll. P. H. Colman, 26/3/73, M.T. *Sprightly*, B.M.R. Stn. S. 73-2052. S.A.M. 12 specimens (2 lots), A.M. 4 specimens (4 lots), total 16 specimens (6 lots).

Discussion. Examination of the 11 paratypes from S.A.M. shows variable axial sculpture, ranging from that of *V. pergradata* s.s. to that of *V. pergradata profundior* Cotton and Godfrey, with the fine axial riblets barely visible, and it appears clear that a depth cline is involved. The specimens are marked as *Cancellaria pergradata* in Verco's handwriting, and a further label marked *Oamaruia profundior* by Cotton has been added, and it is evident that the original author did not consider the differences sufficient to warrant separation.

Genus *Zeadmete* Finlay, 1927

Zeadmete Finlay, 1927: 429. Type species by original designation *Cancellaria trailii* Hutton, 1873.

References: Nil.

Synonyms: Nil.

Diagnosis: Shell very small, 3½ main whorls, strongly shouldered, finely cancellate, aperture elongate-ovate, columella straight with 2 small plaits; off-white. Body-whorl expands rapidly, and 70 per cent of total length.

*Zeadmete kulanda** sp. nov.

Figure 3, (15)

Description: Protoconch 2 depressed convex whorls, smooth and shining, first whorl slightly deviated, merging gradually into sculpture of main whorls, nucleus submerged. *Teleoconch* 3½ flatly convex whorls, vertical at base, strongly and roundly shouldered, flat-topped, body-whorl 70 per cent of total length. *Sutures* strongly incised. *Sculpture* of strong flat-topped transverse cords, slightly narrower than interstices, one on edge of shoulder the strongest, 7 below this and 3 on top of shoulder on penultimate, body-whorl with 5 on top of shoulder and 28 below; vestigial axial riblets barely visible on early whorls, about 18 on second whorl, creating minute nodules at points of intersection with stronger cord on edge of shoulders; crowded microscopic growth lines intersect transverse cords. *Umbilicus* absent. *Aperture* ovate, 75 per cent of length of body-whorl, inner-lip reflected anteriorly as callus over body-whorl; columella straight, one vestigial fold towards base; outer-lip regularly curved, very thin, crenulated exteriorly, no internal lirations; siphonal canal short, broad and open. *Colour* translucent white.

Type locality. 53 km E. × S. of Green Cape, New South Wales, (37°1 7′ S., 150° 35′ E.), 860 metres.

Dimensions. Holotype, length 8·2 mm, breadth 5 mm. Apparently mature.

Location of type. A.M., Sydney, Reg'd No. C. 89275.

Distribution. Type locality only.

Material. Holotype is unique. Coll. "Endeavour", 2/10/1912.

Discussion. The holotype, which is in very fine condition, is the only species known in the genus *Zeadmete* from Australian waters, and in keeping with other deep-water species is extremely thin and fragile. Umbilicus as stated above is absent, the very small fissure visible in the photograph being due to a breakage in the inner-lip callus. Compared with *Zeadmete trailii* Hutton, the type for the genus, the differences are as follows:

*A New South Wales Aboriginal noun meaning "Salt water".

Zeadmete trailii	*Zeadmete kulanda*
Spirals more flat-topped and wider than interstices.	Spirals rounded, interstices equal in width.
Axial riblets over-shadowed by spirals, but still prominent and break spirals in places.	No riblets, spirals intersected only by numerous fine growth lines.
Protoconch prominent and deviated.	Protoconch regular and flatly depressed.
3 medium folds on columella.	One barely visible anterior fold on columella.
Outer lip thicker and with distinct inner nacreous layer.	Outer lip thinner and of one layer only.

INDEX TO SPECIES

Valid names are in italics

LIST OF AUSTRALIAN TERTIARY FOSSIL SPECIES

alveolata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, (1887–88) 11: 154, pl. 10, fig. 7.

Lower beds, Muddy Creek, west of Hamilton, Victoria.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 4·5 mm, breadth 3 mm.

calvulata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 153, pl. 9, fig. 3.

Blue Clays at Fossil Beach, Balcombe Bay, Mornington Peninsula, Vict. Grid. Ref. Cranbourne 072, 845.

Balcombe Clay: Balcombian: Middle Miocene.

Holotype, length 16 mm, breadth 12 mm.

caperata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 158, pl. 9, fig. 7.

Blue Clays at Fossil Beach, Balcombe Bay, Mornington Peninsula, Vict. Grid. Ref. Cranbourne 072, 845.

Balcombe Clay: Balcombian: Middle Miocene.

Holotype, length 5 mm, breadth 2·5 mm.

capillata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 158, pl. 10, fig. 10.

Lower beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 6 mm, breadth 3 mm.

confirmans Ludbrook, 1958. *Cancellaphera, Trans. Roy. Soc. S. Aust.*, 81: 78, pl. 6, fig. 5.

Weymouth Bore, Adelaide, South Australia, 310–330 ft.

Dry Creek Sands: Yatalan: Upper Pliocene.

Holotype, length 8 mm, breadth 5 mm.

epidromiformis Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 154, pl. 8, fig. 9.

Lower beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 20 mm, breadth 10 mm.

etheridgei Johnston, 1880. *Cancellaria, Pap. Proc. Roy. Soc. Tas.*, (1879), p. 32.

Fossil Bluff, Table Cape, near Wynyard, Tasmania.

Table Cape Group: Longfordian: Lower Miocene.

Holotype, length 7 mm, breadth 3 mm.

exaltata Tate, 1889. *Cancellaria, Proc. Roy. Soc. S. Aust.*, 11: 154, pl. 8, fig. 10.

Blue Clays at Fossil Beach, Balcombe Bay, Mornington Peninsula, Vic. Grid Ref. Cranbourne 072, 845.

Balcombe Clay: Balcombian: Middle Miocene.

Holotype, length 19·5 mm, breadth 8·5 mm.

laticostata Tenison-Woods, 1879. *Cancellaria, Proc. Linn. Soc. N.S.W.*, 4: 17, pl. 2, fig. 8.

Cancellaria platypleura Tate, 1898. *J. Proc. Roy. Soc. N.S.W.*, 31: 389. (Invalid name change for *C. laticostata* Tenison-Woods).

Lower beds, west of Hamilton, Muddy Creek, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 6 mm, breadth 3·5 mm.

micra Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 158, pl. 10, fig. 8.

Adelaide Bore, Kent Town, South Australia.

Blanche Point Marl: Aldingan: Upper Eocene.

Holotype, length 3·5 mm, breadth 1·75 mm.

modestina Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 157, pl. 9, fig. 4.

Upper beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 12 mm, breadth 7 mm.

ptychotropis Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 156, pl. 9, fig. 5.

Lower beds, Aldinga, S. Australia.

Blanche Point Marl: Aldingan: Upper Eocene.

Holotype, length 6·25 mm, breadth 3·5 mm.

semicostata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 157, pl. 10, fig. 3.

Lower beds, Muddy Creek, west of Hamilton, Vic.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 3 mm, breadth 2 mm.

tatei Cossmann, 1899. *Cancellaria, Essais de Paleoconch.*, comp., 3: 24 (new name for *Cancellaria gradata* Tate, 1889, non Hoernes, 1856) (*Aneurystoma*).

Lower beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 13·5 mm, breadth 7 mm.

torquayensis Chapman, 1922. *Cancellaria, Proc. Roy. Soc. Vict.*, 35: 16, pl. 3, fig. 25.

Bird Rock cliffs, near Geelong, Victoria.

Jan Juc Formation: Janjukian: Upper Oligocene.

Holotype, length 22 mm, breadth 13 mm.

turriculata Tate, 1889. *Cancellaria, Trans. Roy. Soc. S. Aust.*, 11: 156, pl. 10, fig. 14.

Lower beds, Aldinga, S. Australia.

Blanche Point Marl: Aldingan: Upper Eocene.

Holotype, length 5·75 mm, breadth 2·5 mm.

varicifera Tenison-Woods, 1879. *Cancellaria, Proc. Linn. Soc. N.S.W.*, 3: 231, pl. 21, fig. 12.

Lower beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 19 mm, breadth 9 mm.

wannonensis Tate, 1889. *Cancellaria, Proc. Roy. Soc. S. Aust.*, 11: 156, pl. 8, fig. 11.

Upper beds, Muddy Creek, west of Hamilton, Vict.

Muddy Creek Formation: Balcombian: Middle Miocene.

Holotype, length 29 mm, breadth 17 mm.

FIGURE 1

(1) *Cancellaria* (*Merica*) *elegans* Sowerby, 1822. 49 metres off Island Head, 80 km North of Yeppoon, Q. × 1·7 (33·2 mm x 20·6 mm). A.M. Reg'd No. C. 89756.

(2) *Cancellaria* (*Merica*) *melanostoma westralis* Garrard, subsp. nov. Roebuck Bay, N.W. Australia. × 1·3 (31·5 mm x 20·1 mm). A.M. Reg'd No. C. 89755.

(3) *Cancellaria* (*Merica*) *melanostoma westralis* Garrard, subsp. nov. Holotype. Near Turtle Bay, North-West Cape, W.Aust. × 1·7 (30·2 mm x 19·9 mm). W.A.M. Reg'd No. 697/44

(4) *Cancellaria* (*Nevia*) *spirata* (Lamarck, 1822). Aldinga, South Australia. × 2 (26·5 mm x 18·3 mm). A.M. Reg'd No. C. 89283.

(5) *Cancellaria* (*Nevia*) *spirata* (Lamarck, 1822). Holdfast Bay, South Australia. × 2·2 (26·3 mm x 15·2 mm). A.M. Reg'd No. C. 89284.

(6) *Cancellaria* (*Sydaphera*) *undulata* Sowerby, 1848. Pittwater, N.S.W. × 1·5 (34·7 mm x 20·5 mm). A.M. Reg'd No. C. 89286.

(7) *Cancellaria* (*Sydaphera*) *undulata* Sowerby, 1848. Boatswain's Beach, Kingston, S.E. South Australia. × 1·1 (53·3 mm x 27·5 mm). A.M. Reg'd No. C. 89287. Gerontic specimen, teleoconch 7½ whorls).

(8) *Cancellaria* (*Sydaphera*) *granosa* Sowerby, 1832. Between Stanley and Ulverstone, N.W. Tasmania. × 1·7 (29·6 mm x 18·5 mm). A.M. Reg'd No. C. 89750.

(9) *Cancellaria* (*Sydaphera*) *anxifer* Iredale, 1925. Holotype. Off Eden (Twofold Bay), N.S.W., 45–54 metres. × 1·8 (23 mm x 12 mm). A.M. Reg'd No. C. 53773.

(10) *Cancellaria* (*Sydaphera*) *anxifer* Iredale, 1925. 11 metres, 5 km E. of Forster, N.S.W. × 2·6 (24 mm x 12·5 mm). A.M. Reg'd No. C. 90180.

Photos—Chas. V. Turner, A.M., Sydney.

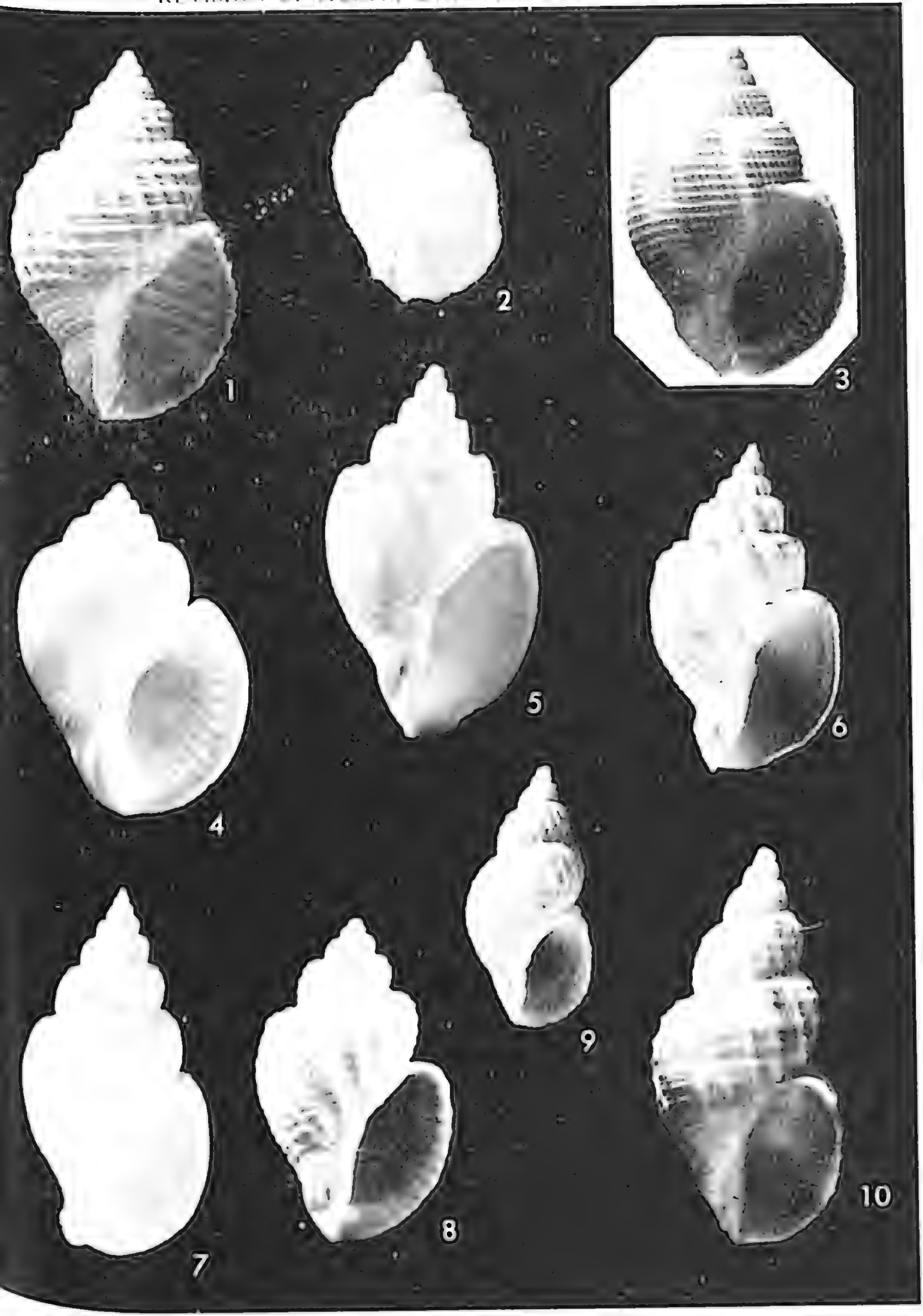
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FIGURE 2

(1) *Cancellaria* (*Sydaphera*) *australis* Sowerby, 1832. "New South Wales". × 2·3 (21·8 mm x 13 mm). B.M.N.H. Reg'd No. 1968388. (Largest of 4 syntypes).

(2) *Cancellaria* (*Sydaphera*) *australis* Sowerby, 1832. "New South Wales". × 3·1 (16 mm x 9·8 mm). B.M.N.H. Reg'd No. 1968388. (Least worn of 4 syntypes).

(3) *Cancellaria* (*Sydaphera*) sp. Off Caloundra, Q. 109–128 metres. × 3·2 (16·9 mm x 10·1 mm). A.M. Reg'd No. C. 89278.

(4) *Cancellaria* (*Sydaphera*) *lactea* Deshayes, 1830. Blackman's Bay, Hobart, Tas. × 2·1 (28·5 mm x 14·4 mm). A.M. Reg'd No. C. 89749.

(5) *Cancellaria* (*Sydaphera*) *lactea* Deshayes, 1830. Flinders, Victoria. × 2·2 (25·2 mm x 15·1 mm). A.M. Reg'd No. C. 89751.

(6) *Cancellaria* (*Sydaphera*) *purpuriformis* Valenciennes (in Kiener), 1841. Off St Francis Island, S. Australia. × 1·8 (28·8 mm x 15·4 mm). S.A.M. Reg'd No. D. 7529.

(7) *Cancellaria* (*Sydaphera*) *panamuna* Garrard, nov. Holotype. 32 km N.W. of Anchor Island. near Onslow, W. Australia. 119 metres. × 3 (17·2 mm x 6·9 mm). In mud, 17/1/60, W.A.M. Reg'd No. 551-71.

(8) *Fusiaphera dampierensis* Garrard, nov. Holotype. 11–12 km N. of Delambre Island, Dampier Archipelago, N.W. Australia, 40 metres. × 4·3 (11·6 mm x 6·6 mm). W.A.M. Reg'd No. 550-71.

(9) *Fusiaphera pallida* (E. A. Smith, 1899). Holotype. Off Cassini Island, Bonaparte Archipelago, N.W. Australia. × 3·9 (10·5 mm x 6 mm). B.M.N.H. Reg'd No. 1891.11.21.96.

(10) *Admetula garrardi* Petit, 1974. N.E. of Cape Moreton, southern Q. 114–124 metres. × 3·7 (11·2 mm x 7·4 mm). A.M. Reg'd No. C. 89279.

(11) *Bonellitia scobina* (Hedley and Petterd, 1906). Holotype. Off Sydney, N.S.W. 549 metres. × 4·5 (8 mm x 5 mm). A.M. Reg'd No. C. 24448.

(12) *Fusiaphera pallida* (E. A. Smith, 1899). Arafura Sea, 161 km N. of Croker Is. Northern Territory, 124 metres. × 3·6 (11·2 mm x 5·8 mm). A.M. Reg'd No. C. 89268.

Photos—Chas. V. Turner, A.M., Sydney, except Nos 1, 2 and 9, B.M.N.H.

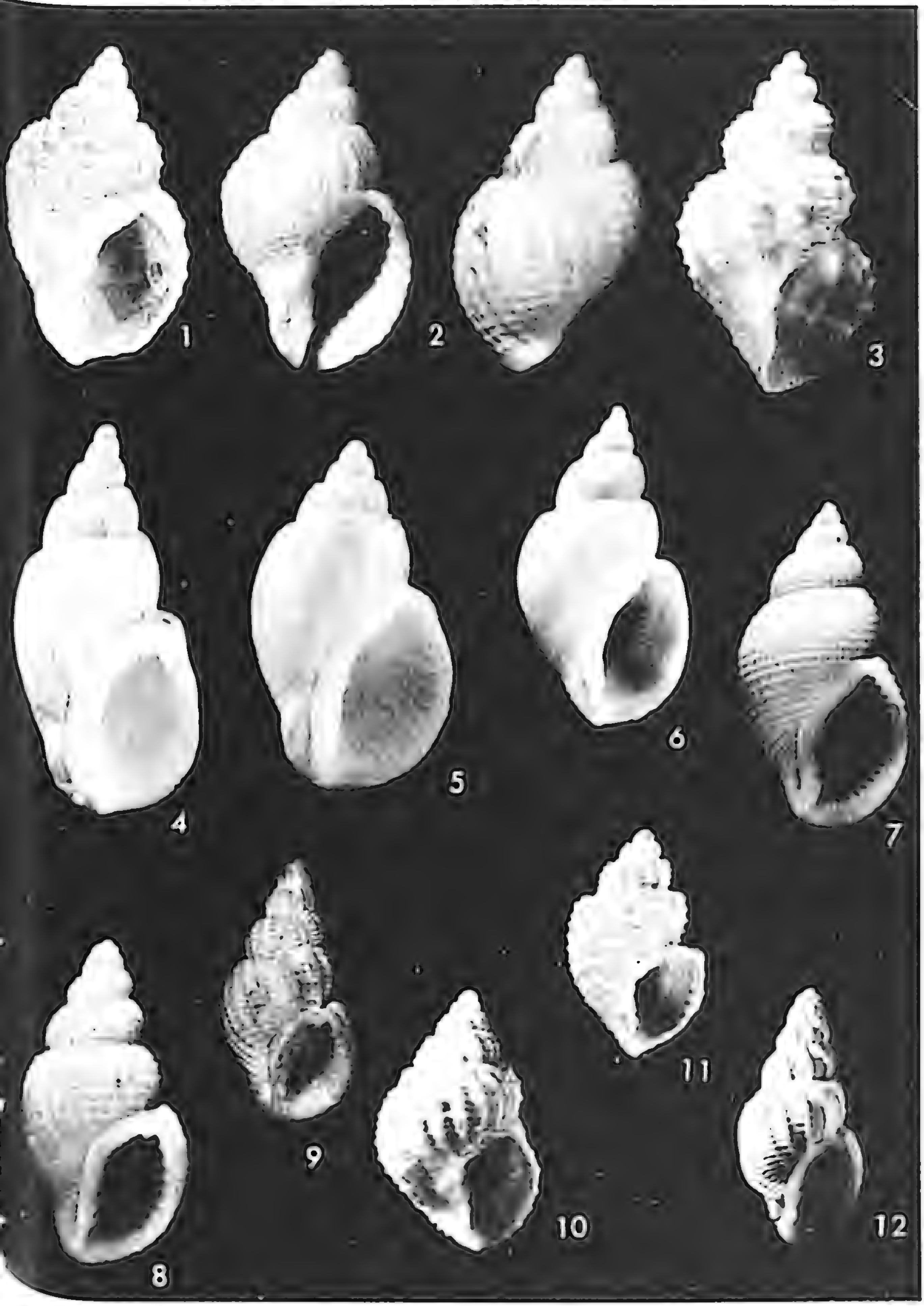
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FIGURE 3

(1) *Trigonostoma textilis* (Kiener, 1841). 23 km W. of Eaglehawk Is., Dampier Archipelago, N.W. Australia, 25 metres. × 2·7 (18·3 mm x 11 mm). W.A.M. Reg'd No. 558-71.

(2) *Vercomaris pergradata* (Verco, 1904). Deep water, St Vincent's Gulf, South Australia. × 4 (10·1 mm x 4·9 mm). A.M. Reg'd No. C. 19969 (Paratype).

(3) *Trigonostoma iota* Garrard, nov. Holotype. N.E. of Cape Moreton, southern Qld. 114–124 metres, × 3·3 (13·2 mm x 7·1 mm). A.M. Reg'd No. C. 89274.

(4) *Trigonostoma diamantina* Garrard, nov. Holotype. N.W. of Bunbury, W. Australia. 201–228 metres. × 4 (12·6 mm x 7·2 mm). W.A.M. Reg'd No. 490-72.

(5) *Trigonostoma vinnula* (Iredale, 1925). Holotype. Off Twofold Bay, N.S.W., 45 metres. × 3·3 (12·5 mm x 7 mm). A.M. Reg'd No. C. 53774.

(6) *Trigonostoma vinnula* (Iredale, 1925). Off Crookhaven, N.S.W., 45 metres. × 2·7 (15·5 mm x 9·5 mm). A.M. Reg'd No. C. 75014.

(7) *Gergovia recessa* (Iredale, 1925). Off Twofold Bay, N.S.W., 82 metres. × 4·1 (8·2 mm x 4·2 mm). A.M. Reg'd No. C. 90152.

(8) *Gergovia recessa* (Iredale, 1925). Holotype. Off Bateman's Bay, N.S.W., 137 metres. × 4·3 (6 mm x 3·5 mm). A.M. Reg'd No. C. 53771.

(9) *Fusiaphera macrospira* (A. Adams and Reeve, 1848). E. of South Keppel Is., Qld, 18–27 metres. × 1·9 (24·6 mm x 11·2 mm). A.M. Reg'd No. C. 89277.

(10) *Trigonostoma bicolor* (Hinds, 1843). Port Curtis, Qld. × 2·4 (18·1 mm x 11·8 mm). A.M. Reg'd No. C. 89269.

(11) *Trigonostoma amasia* (Iredale, 1930). Holotype. Port Curtis, Qld. 16–20 metres. × 2·6 (15 mm x 10 mm). A.M. Reg'd No. C. 57740.

(12) *Trigonostoma amasia* (Iredale, 1930). Port Curtis, Qld. × 2·7 (12·8 mm × 9·4 mm). A.M. Reg'd No. C. 90079. (White specimen.)

(13) *Trigonostoma lamellosa* (Hinds, 1843). Rosemary Is., Dampier Archipelago, N.W. Australia, 5 metres. × 2·3 (22·5 mm x 18·2 mm). W.A.M. Reg'd No. 537-71.

(14) *Trigonostoma scalarina* (Lamarck, 1822). Off Bowen, Qld, 27–45 metres. × 2 (19·1 mm x 11·9 mm). A.M. Reg'd No. C. 90080.

(15) *Zeadmete kulanda* Garrard, nov. Holotype. E. x S. of Green Cape, N.S.W., 53 km, (860 metres). × 4 (8·2 mm x 5 mm). A.M. Reg'd No. C. 89275.

(16) *Trigonostoma antiquata* (Hinds, 1843). 3 metres off Black Is., Whitsunday Group, Qld, Oct., 1969. × 1·9 (23·2 mm x 15·5 mm). Live specimen. Neville Coleman coll.

(17) *Trigonostoma obliquata* (Lamarck, 1822). Huailu, New Caledonia. × 1·3 (25·1 mm x 16·8 mm). A.M. Reg'd No. C. 89281.

(18) *Trigonostoma tessella* Garrard, nov. Holotype. N.E. of Cape Moreton, southern Qld. 114–124 metres. × 1·8 (18·8 mm x 14·3 mm). A.M. Reg'd No. C. 89285.

Photos—Chas. V. Turner, A.M., Sydney.

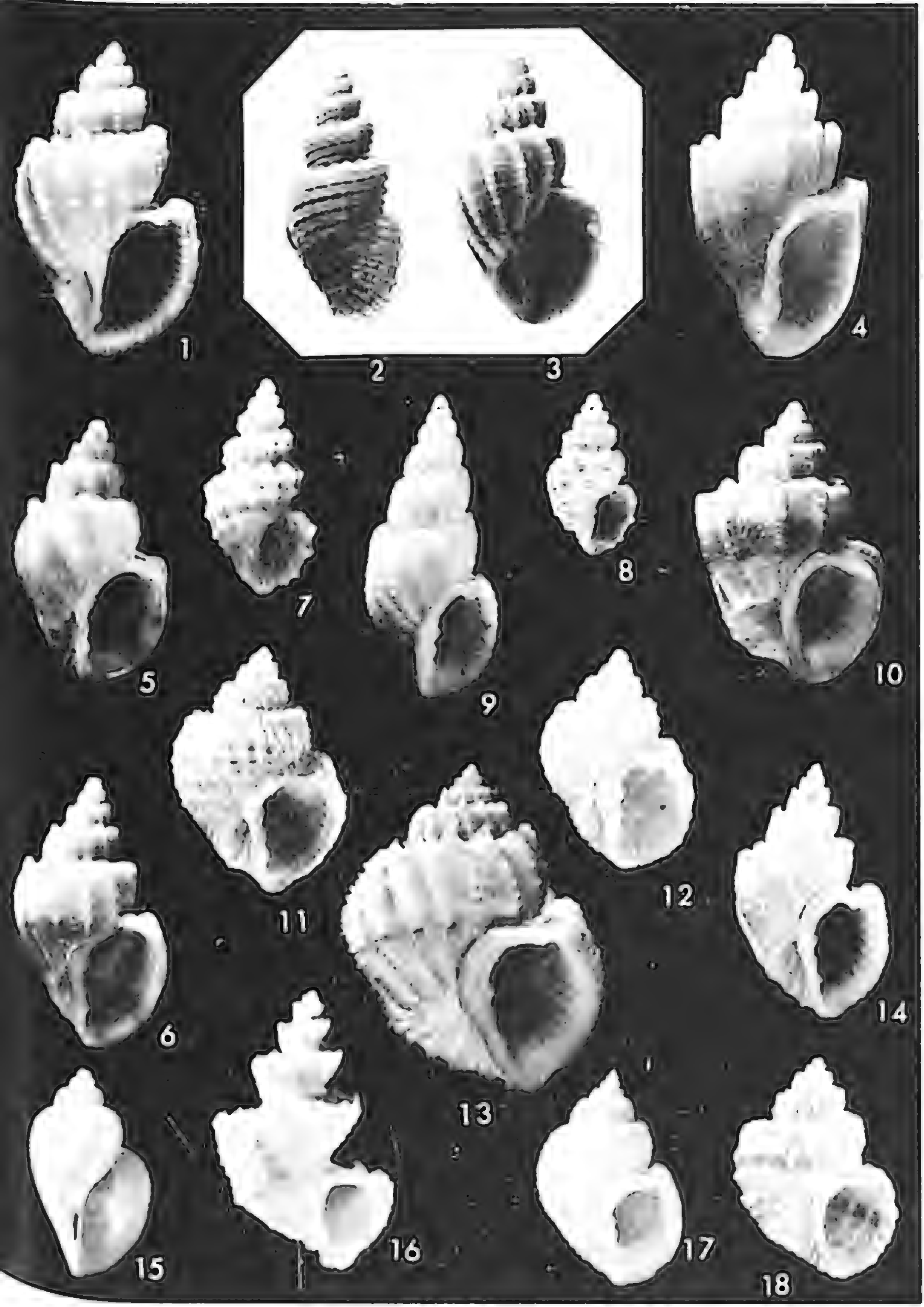
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FIGURE 4

(1) *Gergovia exigua* (E. A. Smith, 1891). S.E. of Lakes Entrance, Vict., 155 metres. × 4·2 (4·9 mm x 3 mm). A.M. Reg'd No. C. 89272.

(2) *Inglisella etheridgei* (Johnston, 1880), 48 km S. of Cape Everard, Vict., 366 metres. × 5·2 (4·9 mm x 2·3 mm). A.M. Reg'd No. C. 89271. ("Endeavour", 22/10/1914).

(3) *Trigonostoma scalariformis* (Lamarck, 1822). Mossman, Qld. × 2·5 (20·3 mm x 11·5 mm). A.M. Reg'd No. C. 83739. (Figured specimen, Rippingdale and McMichael, 1961, pl. 16, fig. 14. *Trigonaphera "crenifera"* Sowerby).

(4) *Trigonostoma scalariformis* (Lamarck, 1822). Off Karumbah, Gulf of Carpentaria. × 2·1 (25·2 mm x 14·2 mm). A.M. Reg'd No. C. 90078. (forma "*bocageana*").

(5) *Pepta stricta* (Hedley, 1907). Holotype. 35 km E. of Narrabeen, N.S.W., 146 metres. × 5·3 (4·5 mm x 1·76 mm). A.M. Reg'd No. C. 25771.

(6) *Pepta simplex* (Laseron, 1955). Holotype. Off Point Halliday, N.S.W., 14–18 metres. × 4·1 (3·9 mm x 1·7 mm). A.M. Reg'd No. C. 80101.

(7) *Gergovia haswelli* Garrard, nov. Holotype. 35 km E. of Narrabeen, N.S.W., 146 metres. × 2 (3·8 mm x 1·9 mm). A.M. Reg'd No. C. 25843.

(8) *Inglisella fischeri* (A. Adams, 1860). "Strait of Corea". × 5·8 (6·9 mm x 3·8 mm). B.M.N.H. Reg'd No. 1968419 (1).

(9) *Inglisella fischeri* (A. Adams, 1860). "Strait of Corea". × 6·2 (6·5 mm x 3·3 mm). B.M.N.H. Reg'd No. 1968419 (2).

(10) *Inglisella fischeri* (A. Adams, 1860). "Strait of Corea". × 5·7 (7·2 mm x 3·4 mm). B.M.N.H. Reg'd No. 1968419 (3).

(11) *Inglisella fischeri* (A. Adams, 1860). S. of Cape Catastrophe, S. Aust., 114 metres. × 4·5 (4·9 mm x 2·7 mm). A.M. Reg'd No. C. 89273.

(12) *Trigonostoma laseroni* (Iredale, 1936). Broulee, near Bateman's Bay, N.S.W. × 2·1 (17·8 mm x 13·7 mm). A.M. Reg'd No. C. 89276.

(13) *Trigonostoma laseroni* (Iredale, 1936). Holotype. Shellharbour, N.S.W. × 3·6 (7 mm x 7 mm). A.M. Reg'd No. C. 60686.

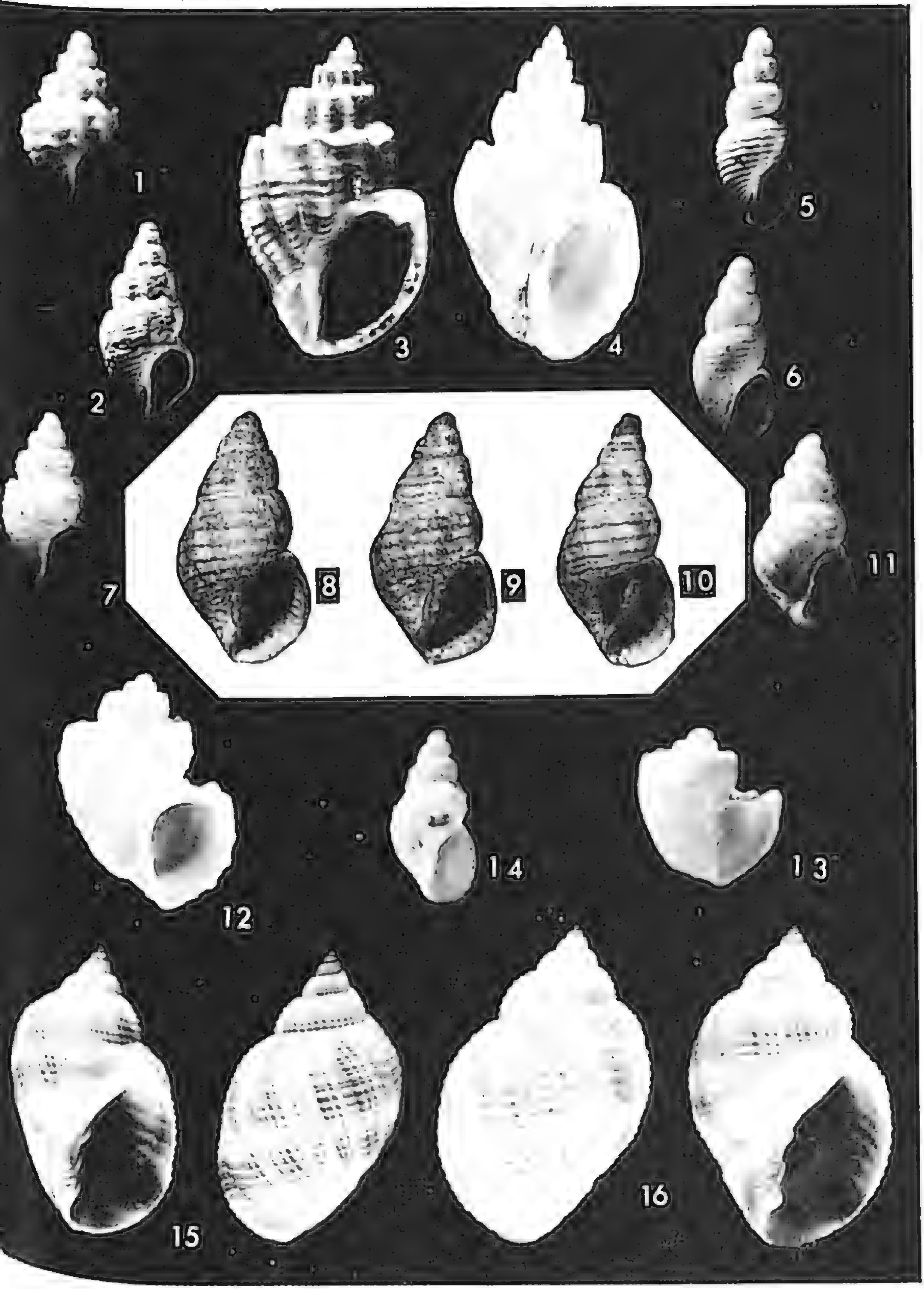
(14) *Inglisella nympha* Garrard, nov. Holotype. 53 km E. × S. of Green Cape, N.S.W., 860 metres. × 4·1 (6·6 mm x 3·2 mm). A.M. Reg'd No. C. 89280.

Non-Australian species

(15) *Cancellaria* (*Merica*) *melanostoma* (Sowerby, 1848). × 1·5 (29·9 mm x 18·2 mm). B.M.N.H. Reg'd No. not available. (Specimen used for Sowerby's figure, 1855, *Thes. Conch.*, 2: 447, pl. 95, fig. 78).

(16) *Cancellaria* (*Merica*) *melanostoma* (Sowerby, 1848). × 1·6 (32·8 mm x 21·2 mm). B.M.N.H. Reg'd No. not available. (Specimen used for Reeve's figure, 1858, *Conch. Icon.*, 10, pl. 6, fig. 26).

Photos—Chas. V. Turner, A.M., Sydney, except Nos 8–10, 15 and 16 by B.M.N.H.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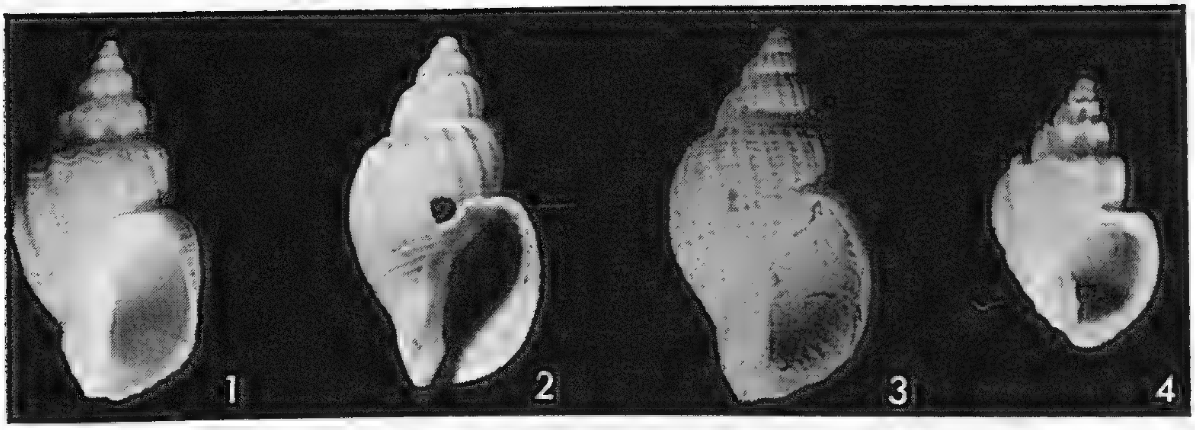

FIGURE 5

(1) *Cancellaria* (*Sydaphera*) *undulata* Sowerby, 1848. (Holotype of *C.* (*S.*) "*renovata*" Iredale, 1929. Sydney Harbour). × 1·1 (37 mm x 20 mm). A.M. Reg'd No. C. 57838.

(2) *Cancellaria* (*Sydaphera*) *undulata* Sowerby, 1848. (Holotype of *C.* (*S.*) "*obnixa*" Iredale, 1936. Richmond River, northern New South Wales). × 1·6 (26 mm x 16 mm), A.M. Reg'd No. C. 60664.

(3) *Cancellaria* (*Sydaphera*) *undulata* Sowerby, 1848. (Holotype of *C.* (*S.*) "*deliciosa*" Laseron, 1955. Woolgoolga, northern New South Wales). × 1·8 (24 mm x 11 mm). A.M. Reg'd No. C. 80102.

(4) *Trigonostoma bicolor* (Hinds, 1843). (Holotype of "*Trigonaphera interlaevis*" Laseron, 1955. Port Stephens, New South Wales). × 2·1 (14 mm x 9 mm). A.M. Reg'd No. C. 10646.

Photos—Chas. V. Turner, A.M., Sydney.

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SILURIAN AND LOWER DEVONIAN FOSSILS FROM THE COBAR AREA OF NEW SOUTH WALES

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SUMMARY

The fossils dealt with in this paper consist mainly of Silurian trilobites from the Mallee Tank Beds and include a new species *Harpes nymageensis*. Two new species of lamellibranchs, *Kochia rayneri* and *Goniophora hermitagensis* are described from the Barrow Range Beds which are considered to be of early Lower Devonian age. These fossils are from a large collection in the Australian Museum from many localities in the Cobar area and consists of materials from the Mallee Tank Beds, the Barrow Range Beds and the Amphitheatre Group.

INTRODUCTION

The collection of fossils was accumulated by the author during a number of visits to the Cobar area with Dr E. O. Rayner, Department of Mines, Sydney. Additional material collected by Messrs C. C. Brooks and R. T. Russell while carrying out geological investigations in the area was presented to the Australian Museum by Cobar Mines Ltd.

The fossil fauna to a great extent bears a marked resemblance to that described by Philip (1962), and Talent (1963, 1965) from the Upper Silurian and Lower Devonian of Victoria. At the present time research is being carried out by Richard Landrum, Australian National University, Canberra, on a comprehensive collection of fossils recently collected by him from the Barrow Range Beds and the Amphitheatre Group in the Cobar district. Similar material in the Australian Museum collection has been made available to Mr Landrum to assist, if necessary, in his research.

MALLEE TANK BEDS

Outcrops of the Mallee Tank Beds, mainly shales and sandstones, occur in an area about 43·5 km (27 miles) east of Cobar and south of the railway line with a southeasterly trend towards Nymagee. Fossils are fairly numerous in most outcrops and include *Plasmopora*, *Favosites*, a species of small rugose coral (internal casts), *Mycophyllum liliiforme*, *M. crateroides*, trilobites described in this paper and a variety of brachiopods with other groups less represented. The age of the Mallee Tank Beds is generally considered to be late Silurian (i.e.) Pridelian. An interesting trilobite however, *Thomastus thomastus*, was found in considerable numbers at a locality 7·6 km (4·7 miles) northeast of Nymagee on the Hermidale Road, thence

Records of the Australian Museum, 1975, **30**, 63–85, figures 1–5
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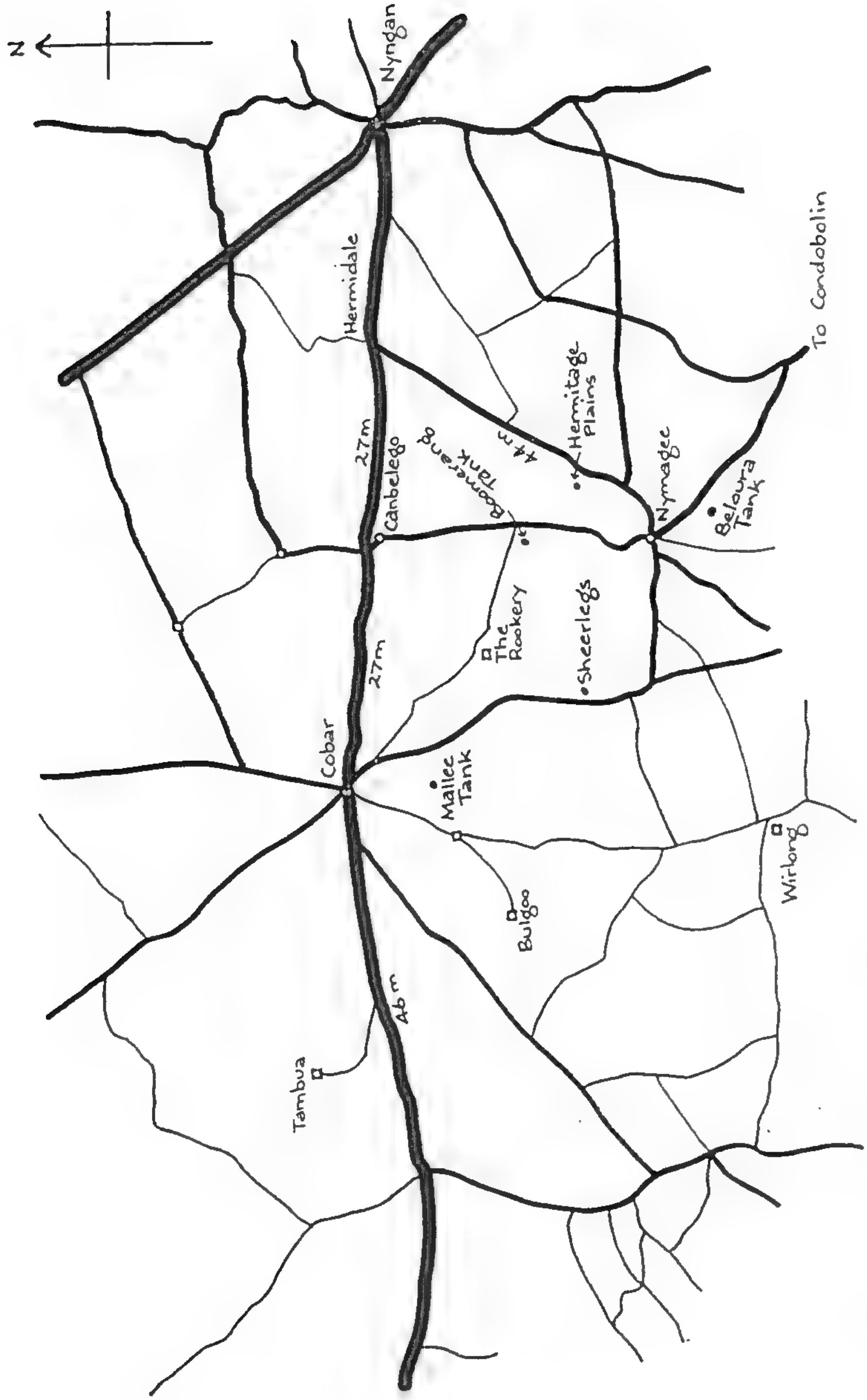

FIGURE 1. Map of the Cobar district, Western New South Wales, showing the main locations mentioned in the accompanying paper.

0·4 km ($\frac{1}{4}$ mile) southeast. It was found in association with *Harpes nymageensis*, *Cheirurus* (*Crotalocephalus*) *silverdalensis* and various brachiopods. Öpik (1953, p. 23) described and named *Thomastus thomastus* from the "*Illaenus* Band" at the base of the Wapentake Formation at Heathcote, Victoria, which is of Lower Silurian age. The species has also been collected by the writer, but not previously recorded, from the Rosyth Limestone Member of the Panuara Formation near Borenore, New South Wales, where it is a common form. A relatively large, poorly preserved pygidium, collected from Scrubby Valley, 13·6 km ($8\frac{1}{2}$ miles) east of Cobar on the Nyngan Road, thence 2·8 km (1·7 miles) south, closely resembles that of *Encrinurus borenorensis*, so far known only from the Rosyth Limestone Member where it is found associated with *Thomastus*. The presence of these two forms in the Mallee Tank Beds, particularly *Thomastus*, suggests they may be lower in the Silurian sequence than usually recognized.

Isolated limestone outcrops are found at Boomerang Tank, 26 km (16 miles) south of Canbelago, at the Rookery, 33·79 km (21 miles) southeast of Cobar, at Beloura Tank, 18 km (11 miles) southeast of Nymagee, and also near Mallee Tank, 18 km (11 miles) south of Cobar. The rich faunas of these limestones are generally very similar and a late Silurian age has usually been attributed to them. Öpik, following the identification of brachiopods and trilobites from the Rookery (*in* Iten and Carter, 1951) concluded that the age is late Silurian or early Devonian. Following an examination of conodonts from the Rookery Limestone, Pickett (1974, p. 1) supported an early Devonian age, as he suggested an age equivalent with the lower part of the Siegenian Garra Formation.

Lloyd (1939) recorded *Calymene australis*, identified by the writer, from a bed of chert in Parish Howgill, County Flinders, which he placed in the Ballast Group. The trilobites were collected from Boomerang Tank on Kopyge station, a locality within the Parish Howgill, by J. Harrison (pers. comm.), who accompanied Lloyd, but it is doubtful if the bed is part of the Ballast Group. The occurrence of *Gravicalymene australis*, now recognized in this paper as *G. angustior*, in the Ballast Group, was queried by Moye (1969, p. 99). This species is not uncommon in the early Devonian. At a locality 5·6 km ($3\frac{1}{2}$ miles) due south of Mafeesh Homestead, 9·65 km (6 miles) east-southeast of Shearleg's Tank, C. Brooks collected specimens of *G. angustior* in a chert with a similar state of preservation as those from Boomerang Tank. Calymenids have also been collected from Vambi Homestead and Beloura Tank but to my knowledge not from the older Mallee Tank Beds. Furthermore, a tuberculate pygidium of *Scutellum* from Boomerang Tank has a close resemblence to *Scutellum* sp. indet., described by Strusz (1964, p. 92) from the Garra Formation of the Wellington–Canobolas District of New South Wales.

THE BARROW RANGE BEDS

The Barrow Range Beds are exposed on the eastern margin of the Cobar Basin and particularly at Hermitage Plains Station, in the Barrow Ranges, 48·28 km (30 miles) from Hermidale on the Nymagee Road where outcrops are richly fossiliferous. Extensive outcrops occur at Prince's Tank, northwest of the Homestead, and also form a low range about 0·8 km (0·5 miles) southeast of Prince's Tank which extends to the Hartwood area.

The fauna of the Barrow Range Beds is quite distinct from that of the Mallee Tank Beds and the limestone outcrops. In the vicinity of Prince's Tank a shallow water assemblage of heavy-shelled lamellibranchs include a new species, *Kochia rayneri*, a genus known previously only from early Lower Devonian of Western Europe. Also a new large-shelled species, *Goniophora hermitagensis*, which has a close relationship with species from the Hamilton Stage (Lower Devonian) of New York, U.S.A., while many species of actinopterids are identical with forms described and figured by Talent (1965, pp. 38–39) from the Mt Ida Formation of the Heathcote District and from the Kilgower Member (1963, pp. 88–89) of the Wentworth Group in eastern Victoria. A different type of fauna is found in the low range to the southeast of Prince's Tank with brachiopods the dominant group and is of a deeper-water origin than the fossils already referred to.

A narrow band of fine shale outcropping below a hill-top on the western bank of a small creek about 2·10 km (0·9 miles) north-northwest of Prince's Tank contained *Encrinurus mitchelli*, *E. silverdalensis*, *Stropheodonta* sp., a small rugose coral and *Favosites* sp. The bed containing these forms which are typical of the Mallee Tank Beds fauna and were found nowhere else in the Prince's Tank area overlies, and is conformable with, a considerable thickness of beds considered to be of Lower Devonian age. This is the occurrence of *Encrinurus* mentioned by Webby (1972, p. 101) and, as he states, raises the possibility of the Barrow Range Beds being in part Late Silurian. It is an interesting occurrence and a more detailed examination of the area should be made so that the exact relationships of the beds can be resolved.

THE AMPHITHEATRE GROUP

Shales and sandstones of the Amphitheatre Group are recorded as cropping out over a triangular area west of Cobar, the apex of which is about 130 km (80 miles) west of Cobar, the base a roughly meridional line through Cobar and extending for about 80 km (50 miles) to the north and the same distance south. Outcrops are numerous and generally have yielded a rich fauna of late Lower Devonian age. Brachiopods are numerous and a wide variety include dominant forms such as *Howellella* spp., *Isorthis* spp., and *Iridistrophia*. Lamellibranchs are also common and include species of *Leptodesma*, *Leiopteria*, *Goniophora* (small forms), *Actinopteria* and *Modiomorpha*. Many of the species are similar to those described and figured by Talent (1963, 1965) and others from Lower Devonian beds of Victoria.

Practically all the species recorded by Dun (1898, pp. 160–174) from Devonian boulders in the Cretaceous of White Cliffs, New South Wales, are represented in the fauna of the Amphitheatre Group. Of these, an incomplete brachial valve, named and figured by Dun (1898, p. 163, pl. 17, fig. 1) as *Schizophoria* sp. indet., was perhaps the most abundant form found in the Amphitheatre outcrops and particularly those to the west and north-west of Cobar. The figured specimen, A.M. F.50979, now in the Australian Museum collection, has been placed in the genus *Iridistrophia* by Landrum (per. comm.). Rose and Brunker (1969) have suggested that the Barrow Range Beds are a littoral facies of the Amphitheatre Group.

Recent research by Ritchie (1969, 1973) on fish remains collected from the lower part of the Mulga Downs Formation led him to the conclusion that the beds in which they occur are older than originally thought and he assigned them to the late Lower Devonian–early Middle Devonian (Emsian-Eifelian). It seems therefore, that the age of the underlying Amphitheatre Group, from which similar fish remains have been collected from several localities, is younger than the Barrow Range Beds which with its distinctive fauna, including *Kochia*, is probably early Lower Devonian.

SYSTEMATIC PALAEONTOLOGY

PHYLUM MOLLUSCA
Class Lamellibranchiata
Superfamily Pteriacea Dall
Family Kochiidae Mallieux, 1931
Genus *Kochia* Frech, 1889
Kochia rayneri sp. nov.
Figure 5, A–F

Holotype A.M. F.47467, paratype A.M. F.55041—Australian Museum Collection.

Description: Shell capuliform and very inequilateral. Left valve large, inflated, somewhat reversed S-shaped and strongly arched, narrow dorsally and gradually widening towards the ventral margin and terminating in a bluntly pointed, somewhat wedge-shaped, postero-ventral extremity. Dorsal half of the valve twisted anteriorly and strongly curved to form a sharply pointed and abruptly incurved umbo which is in close contact with the anterior margin of the valve at its dorsal extremity. Anterior margin is highly arched, particularly in the dorsal area where it is bordered by a well defined groove. Posterior margin almost straight then slightly curving to the posterior triangular wing. In the dorsal area the valve surface slopes steeply to the posterior margin and is much greater in depth than the slightly curved and narrow anterior slope. Hinge-line straight and relatively short. Surface ornament is limited to coarse growth lamellae. The right valve is unknown but is probably operculate, thin and flattened.

Dimensions: Height of left valve (holotype) 36 mm, length 21 mm, but specimens attaining a length of up to 53 mm were collected.

Remarks: This outstanding species occurs in considerable numbers at the type locality and is represented in the collection by about eighty left valves. A close and extensive search failed to locate any right valves.

The only Australian reference to the genus *Kochia* is by Dun and Benson (1920, p. 353) when they described and figured a new species, *K. striata*, from the Lower Carboniferous near Carroll, New South Wales. The single specimen, a left valve, differs from *K. rayneri* in being much less convex, the anterior margin is not highly arched and the surface ornamentation consists of radial folds. It is doubtful if *K. striata* is correctly placed in the genus *Kochia*, so far known only from the early Lower Devonian.

Kochia rayneri differs from the type species, *K. capuliformis* Frech (1891, pp. 72–78, pl. 6) in that the groove bordering the highly arched anterior margin is less developed, the beak is more twisted and closely incurved and the ventral half of the valve is much wider.

The specific name of this species is given for Dr E. O. Rayner, former Assistant Under-Secretary, Department of Mines, Sydney, in recognition of his geological investigations in the Cobar district.

Localities: Slope from creek about 0·10 km (0·6 mile) north of Prince's Tank, Hermitage Plains Station, 48·28 km (30 miles) from Hermidale on the Nymagee Road (Type Locality); near an old mine-shaft about 3·21 km (2 miles) south of Prince's Tank.

Geological Age: Early Lower Devonian.

Family Modiolopsidae Fischer, 1887
Genus *Goniophora* Phillips, 1848
Goniophora hermitagensis sp., nov.
Figure 4C and D

Holotype A.M. F.47967; paratype A.M. F.46822, Australian Museum Collection.

Description: Shell laıge, equivalve, length three times the height, compressed anteriorly and inflated posteriorly. An oblique sinus extending from the umbo to the ventral margin causes a constriction of the shell about the mid-line. Umbo small and incurved only slightly raised above the hinge-line and situated in less than the anterior one-fifth of the valve. Anterior end short, compressed, somewhat attenuated, the margin extending almost straight from the umbo and rounded below. Posterior end of valve very much elongated, inflated and somewhat wedge-shaped; a prominent and angular umbonal ridge extends from the umbo to the postero-ventral extremity. Posterior margin obliquely truncate. Ventral margin curved anteriorly with a wide sinus in the middle beyond which it is almost straight posteriorly. Internal characters of the hinge have not been observed. Surface ornament consists of moderately coarse concentric growth lines which are acutely recurved at the umbonal ridge.

Dimensions: The holotype is 100 mm long and 33 mm high; paratype 95 mm long and 32 mm high. One specimen (F.47962) has a length of 118 mm and a height of 34 mm.

Remarks: This species is represented by three fairly complete and well preserved left valves, a right valve and several incomplete specimens. It is characterized by its large size, the extreme length of the valves in comparison with the height, the compressed, short anterior end, the depressed area anterior to the middle and the elongated, inflated, posterior. The species is not close to any previously described forms of *Goniophora* from Australia which have been shells of relatively small size. It differs considerably from *G. hendersoni* from the Reefton Beds (Lower Devonian) in New Zealand, described by Allan (1935, p. 25), specimens of which attained a length of 55 mm and a height of 25 mm. In general outline there is a close resemblance between *G. hermitagensis* and *G. acuta* Hall (1885, pp. 295–296, pl. 43, figs 1–3) from the Hamilton Stage (Middle Devonian) of New York, U.S.A., specimens of which are 80 mm in length.

Locality: About 0·4 km (0·25 miles) east of Prince's Tank, Hermitage Plains Station, 48·25 km (30 miles) from Hermidale on the Nymagee Road.

Geological Age: Early Lower Devonian.

Phylum Trilobita

Family Thysanopeltidea Hawle and Corda, 1847
Genus *Scutellum* (*Scutellum*) Pusch, 1833
Scutellum (*Scutellum*) sp. indet.
Figure 2A

Description: Pygidium broadly semi-circular in outline; surface flattened, elevated, narrow lateral and posterior marginal areas concave with a well-defined smooth border. Axis small and triangular without longitudinal furrows, evenly convex, the surface covered with irregularly arranged tubercles. Each pleural field

bears seven radiating flat lateral ribs separated by narrow well pronounced pleural furrows. The median rib is relatively wide, undivided, slightly expanded at its junction with the axis, then narrowing before gradually widening posteriorly. Five curved ribs on each side of the median rib are somewhat pointed at their junction with the axis and gradually expand towards the border. The two uppermost ribs in each field show little curvature, are wider than the preceding ribs and their greatest width is in the central area. Thorax and cephalon are unknown.

Dimensions: Width 25 mm, length 15 mm.

Remarks: This specimen (F.46829), an incomplete but well preserved pygidium, closely resembles that of *Scutellum* sp. indet., described and figured by Strusz (1964, p. 92) from the Garra Formation (Lower Devonian), but differs in that the axis is not trilobed and also in the more widely semi-circular outline. Other tuberculate species of *Scutellum* from New South Wales, described by Etheridge and Mitchell (1917), consist of *S. bowningensis* from the Upper Trilobite Bed of the Yass district and *S. mesembrinus* from limestone beds adjacent to Molong (? Upper Silurian). In the former species the axis of the pygidium is trilobed and there is only faint evidence of granulation while in the latter species the axis is not trilobed but it differs markedly from the present form in that the ribs are narrow, angulate, with moderately wide furrows and each rib bears a single row of tubercles. Chapman (1915, p. 160) described two tuberculate species as *Bronteus* (*Goldius*) *greeni* and *B.* (*Goldius*) *creswelli* from the Yeringian of Victoria. The former species is not a *Scutellum* and the latter species bears little resemblance to the present form from Boomerang Tank. Öpik (*in* Iten and Carter, 1951) recorded *Scutellum*(?) from the Rookery, southeast of Cobar, but I have no information concerning this specimen.

Locality: Boomerang Tank, 26 km (16 miles) south of Canbelago.

Geological Age: Late Upper Silurian.

Family Illaenidae Hawle and Corda, 1847

Subfamily Bumastinae Raymond, 1916

Genus *Thomastus* Öpik, 1953

Thomastus thomastus Öpik

Figure 2, B–D

1937 *Illaenus* sp. Thomas, D. E., *Min. geol. Jour. Victoria*, 1, (1), p. 66.

1953 *Thomastus thomastus* Öpik, A. A., *Mem. geol. Surv. Victoria*, 19, p. 23, pl. 8, figs 61–71, text fig. 8.

1965 *Thomastus thomastus* Talent, J. A., *Ibid.*, 26, p. 47.

Remarks: Numerous cephala and pygidia of this species are present at the locality near Nymagee but in most cases are somewhat crushed and distorted. The tests are somewhat worn on the surface and show little or no trace of ornamentation. External moulds of two shields (F.44318a and F.42699) show traces of terraced lines on the surface and doublure.

This species was originally described and figured by Öpik from the "*Illaenus* Band" at the base of the Wapentake Formation (Lower Silurian) at Heathcote, Victoria, where it is a widely distributed and characteristic fossil. Similar specimens have been collected by the author, but not previously recorded, from the Rosyth Limestone Member (Lower Silurian) at "Rosyth", a property near Borenore, New South Wales. At this locality the species is also very common and is associated with an abundance of halysitid species and trilobite genera, *Encrinurus*, (?)*Acernaspis* and *Dicranogmus*. Specimens of *T. thomastus* from Nymagee and Borenore are identical in dimensions and characters with the type material of the species in the collection of the Bureau of Mineral Resources, Canberra.

Locality: 7·6 km (4¾ miles) northeast of Nymagee on the Nymagee-Hermidale Road, then 0·4 km (0·25 miles) southeast.

Geological Age: Mallee Tank Beds, (?) Lower Silurian.

Family Harpidae Hawle and Corda, 1847

Genus *Harpes* Goldfuss, 1839

Harpes nymageensis sp. nov.

Figure 2E

Holotype: A.M. F.50030, counterpart A.M. F.50029 (incomplete cephalon), Australian Museum Collection.

Description: Cephalon moderately large, approximately 30 mm wide and including the occipital ring 26 mm long. Outline rather narrowly curved in front with almost straight, slight inwardly sloping long genal prolongations. Glabella strongly convex with faint posterior lateral lobes, alae small and depressed. Eye tubercles slightly posterior of the anterior glabella extremity. Two furrows diverging forward from the glabella to the inner margin of the fringe enclose a small elevated preglabellar field. Genae narrow with steeply sloping sides. Brim broad and flattened. Thorax and pygidium unknown.

Remarks: This species is known only by an incomplete cephalon. Its outstanding characters are quite dissimilar to those of *Harpes trinucleoides* Etheridge and Mitchell (1917, p. 496) from the Upper Silurian at Bowning, New South Wales, but in some respects resembles a cephalon of *Harpes* figured by Talent (1963, p. 105, pl. 77, figs 13–14) from the Kilgower Member of the Tabberaberra Formation of Victoria. There appears to be a similarity in general appearance between *H. nymageensis* and *H. ungula* Sternberg, which however occurs in the Middle and Upper Silurian of Czechoslavakia. In both species the genae and glabella are very much elevated above the brim and the sides of the genae are steeply sloping but *H. nymageensis* is larger in size and differs in the shape of the glabella. De Koninck (1877, p. 59) recorded a complete head-shield of *H. ungula*, only 3 mm long, from a limestone at Boree Caves, New South Wales.

Locality: 7·6 km (4·75 miles) northeast of Nymagee on the Nymagee-Hermidale Road, then 0·4 km (0·25 miles) southeast.

Geological Age: Mallee Tank Beds, (?)Lower Silurian.

Family Cheiruridae Salter, 1864

Genus *Cheirurus* Beyrich, 1853

Subgenus *Crotalocephalus* Salter, 1853

Cheirurus (*Crotalocephalus*) *silverdalensis* Etheridge and Mitchell.

Figure 2, F–G

1917 *Crotalocephalus silverdalensis* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 42 (3), p. 490, pl. 24, fig. 10; pl. 25, figs 1–3 and 9.

1962 *Cheirurus* (*Crotalocephalus*) *silverdalensis* Philip, *Proc. R. Soc. Vict.*, 75 (2), p. 228.

Remarks: The glabella in three specimens of this species, one with portions of the fixigenae attached, is approximately 21 mm in length and 12 mm wide. The characters agree with those of the type material described by Etheridge and Mitchell from the Hume Series of the Yass district, New South Wales, and also with specimens recorded by Philip from the Boola Beds of the Tyers areas in Victoria. A closely allied species, *C. sculptus* Etheridge and Mitchell (1917, p. 492) differs from *C. silverdalensis* in the slightly larger glabella being more anteriorly placed and the glabella furrows more acutely V-shaped. Strusz (1964, p. 98) in describing a new species *C. packhami* from the Garra Formation of New South Wales included in the synonomy a cephalon figured by Etheridge and Mitchell (1917, pl. 26, fig. 11) as *C. sculptus*. This specimen is not included in the type material of the species in the Australian Museum collection and is apparently missing. *C. packhami* differs from *C. silverdalensis* in the parallel-sided glabella, the gently V-shaped trans-glabella furrows and the fixigenae being narrower than the occipital ring.

Localities: 7·6 km (4¾ miles) northeast of Nymagee along the Nymagee-Hermidale Road, then 0·4 km (0·25 miles) southeast; 7·2 km (4·5 miles) southeast of Nymagee along Nymagee-Condobolin Road, then 2·4 km (1·5 miles) northeast.

Geological Age: Mallee Tank Beds, (?)Lower Silurian.

Family Encrinuridae Aneglin, 1854

Subfamily Encrinurinae Angelin, 1854

Genus *Encrinurus* Emmrich, 1844

Encrinurus cf. *silverdalensis* Etheridge and Mitchell

Figure 3, C–E

1915 *Encrinurus silverdalensis* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 40 (4), p. 665, pl. 54, fig. 11; pl. 55, figs 4, 8; pl. 56, figs 4–6, 14; pl. 57, figs 3, 10.

1948 *Encrinurus* cf. *silverdalensis* Gill, *Rec. Queen Vic. Mus.*, 2 (2), p. 68, pl. figs 7–8.

Remarks: Two free cheeks and several incomplete pygidia have been tentatively identified as the above species. One well preserved right free cheek bears two rows of tubercles on the border consisting of an inner row of relatively large flattened, elongate tubercles and an outer row of smaller ones. This appears to be a characteristic feature of *E. silverdalensis* and is not present in allied species of comparable size such as *E. bowningensis* and *E. etheridgei*. Several pygidia possess features consistent with *E. silverdalensis* in that they are of comparatively large size and widely triangular.

The type locality of *E. silverdalensis* is Yass, New South Wales, where the species is found in the Lower Trilobite Bed—Hume Series. Gill (1948, p. 168) recorded *E.* cf. *silverdalensis* from an horizon in the Eldon Group near Queenstown, Tasmania, which he suggested was on the Siluro-Devonian boundary but Philip (1960, p. 154) later considered the fauna of the horizon is Upper Silurian.

Localities: (1) Scrubby Valley, 13·6 km (8·5 miles) from Cobar on the Nyngan Road, thence 2·8 km (1·7 miles) south (A.M. F. 50873, A.M. F.49927); (2) 7·6 km (4·5 miles) southeast of Nymagee along Nymagee-Condobolin Road, thence 2 km (1·25 miles) northeast; F.50037 (3) below hill-top on western bank of small creek about 2·10 km (1·9 miles) north-northwest of Prince's Tank, Hermitage Plains Station (A.M. F.47673).

Geological Ages: Localities (1–2)—Mallee Tank Beds, (?)Lower Silurian; locality (3)— (?)Barrow Range Beds, Lower Devonian.

Encrinurus mitchelli Foerste

Figure 3A; Figure 4I

1877 (?)*Cromus murchisoni* De Koninck, *Soc. des. Sci. Nat. Liege, Mem.* Ser. 2, p. 54, pl. 1, fig. 9.

1888 *Encrinurus mitchelli* Foerste, *Bull. Denison Univ.*, 3, p. 124, pl. 15, figs 2–3, 20.

1915 *Encrinurus mitchelli* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 40 (4), p. 657, pl. 54, figs 1–5; pl. 55, figs 1–3, 15; pl. 56, figs 2, 10; pl. 57, fig. 9.

Remarks: A slightly crushed pygidium with eight attached thoracic segments is similar to a specimen figured by Etheridge and Mitchell (1915, pl. 54, fig. 5) from the Lower Trilobite Bed at Bowning, New South Wales. The pygidium is approximately twice as long as wide with ten pleural ribs. The axis tapers to form a bluntly pointed extremity and has about twenty-six axial ribs with occasional tubercles developed on smooth areas. An incomplete cranidium is smaller in size than typical examples of *E. mitchelli* but in all other aspects is identical.

Vogdes (1907, p. 77) considered that *Cromus murchisoni*, described and figured by De Koninck from the Silurian at Quidong, New South Wales, and placed doubtfully as a synonym of *E. mitchelli* by Etheridge and Mitchell, was distinguished from that species and *E. bowningensis* by the shape of the glabella and depth of the furrows which separate it from the fixigenae.

Locality: Below a hill-top on the western bank of a small creek about 2·10 km (1·9 miles) north-northwest of Prince's Tank, Hermitage Plains Station, 48·28 km (30 miles) from Hermidale on the Nymagee Road.

Geological Age: (?)Barrow Range Beds, Lower Devonian.

Encrinurus af. *borenorensis* Fletcher
Figure 5G

1950 *Encrinurus borenorensis* Fletcher, *Rec. Aust. Mus.*, 22 (3), p. 227, pl. 15, figs 1–7; pl. 16, figs 1, 5–6.

Remarks: An incomplete and poorly preserved pygidium consisting of a left pleural lobe and axis is doubtfully referred to the above species. The pygidium is the largest found in the Mallee Tank Beds and its dimensions agree with those of *E. borenorensis.* The pleural ribs are ten in number, divided by wide furrows, almost straight for some distance from the axial furrow and then bend rather sharply posteriorly. The axis, although only partly preserved, show numerous axial rings which in *E. borenorensis* number twenty-two. This species, the largest known Australian encrinurid and was described from "Rosyth", a property near Borenore, New South Wales, where it is a common form in the Rosyth Limestone Member (Panuara Formation). Associated with it are numerous halysitids and trilobites including *Thomastus thomastus*, *Dicranogmus bartonensis* and (?)*Acernaspis macdonaldi.*

Locality: Scrubby Valley, 13·8 km (8·5 miles) from Cobar on the Nyngan Road, thence 2·8 km (1·7 miles) south.

Geological Age: Mallee Tank Beds, (?)Lower Silurian.

Encrinurus sp. indet.
Figure 5H

Remarks: A small incomplete pygidium, approximately 8 mm wide and 6 mm long, with steeply sloping pleural lobes, is practically identical with a pygidium from the Silurian of Duntroon, A.C.T., which was figured but not specifically named by Etheridge and Mitchell (1915, p. 674, pl. 55, fig. 14). The axis prominent, keel-like and tapers to an acute termination posteriorly. Axial rings do not appear to be developed, at least on the lower part of the axis, the only portion preserved on the specimen.

Locality: Below hill-top on western bank of small creek about 2·10 km (1·9 miles) north-northwest of Prince's Tank, Hermitage Plains Station.

Geological Age: (?)Barrow Range Beds, Lower Devonian.

Family Calymenidae Burmeister, 1843
Subfamily Calymeninae Burmeister, 1843
Genus *Gravicalymene* Shirley, 1936
Gravicalymene angustior (Chapman)
Figure 2G–H; Figure 3A–B.

1915 *Calymene angustior* Chapman, *Proc. R. Soc. Vict.*, 28 (1), p. 165, pl. 15, figs 8–10.

1938 *Calymene* (*Gravicalymene*) (?)*angustior* Shirley, *Q. Jl. geol. Soc. Lond.*, 94 (4), p. 487, pl. 44, fig. 17.

1945 *Gravicalymene angustior* Gill, *Proc. R. Soc. Vict.*, 56 (N.S.), (2) p. 176, pl. 7, figs 5–10.

1962 *Gravicalymene angustior* Philip, *Proc. R. Soc. Vict.*, 75 (2), p. 231, pl. 35, figs 16–17.

1963 *Calymene* (?*Gravicalymene*) *angustior* Talent, *Mem. geol. Sur. Vict.*, 24, p. 100, pl. 74, figs 5–9; pl. 75, figs 12–15.

1965 *Gravicalymene* cf. *angustior* Talent, *Ibid.*, 26, p. 49, pl. 26, figs 3–5.

Remarks: A series of well preserved but incomplete cranidia and pygidia from Boomerang Tank and from near the Mafeesh Homestead possess features similar to those attributed to *G. angustior*. Doubt still persists with some authors whether the characters of G. *australis* and *G. angustior* are specific or simply variations. Philip (1962, p. 231), in describing a cranidium and pygidium from the Boola Beds of the Tyers Area of Victoria as *G. angustior*, was not fully convinced that the two species are separable and also that they and other closely related eastern Australian species are rightfully placed in the genus *Gravicalymene*.

Shirley (1938, p. 487) in recording *G.* (?)*angustior* from the Baton River Beds of New Zealand placed *Calymene australis* Etheridge and Mitchell (1917, p. 481) in the synonomy of that species with the exception of specimens figured on pl. 24, fig. 5 (F.36172), pl. 27, fig. 1 (F.36168) and with some doubt pl. 24, fig. 4 (F.36173). In the opinion of B. Chatterton specimen F.36168 is not the same genus or species as the other paralectotypes of *C. australis* (pers. comm.).

Gill (1945, p. 176) considered that the two species were synonymous but later (1948, p. 69), following an examination of the type material, decided they should be separated. He concluded that *G. angustior* has a far more highly inflated glabella than *G. australis*, that the rolled edge on the margin of the pre-glabellar field is less developed and that *G. australis* has one axial segment less in the pygidium.

Strusz (1964, p. 95) believes that *G. angustior* is specifically different from *G. australis* and pointed out that in the latter species the three posterior glabellar lobes are larger and more clearly separated from the axis of the glabella and the frontal lobe is more quadrate in outline. These are reasonably well marked points of difference and together with the characters defined by Gill appear to warrant separation of the two species.

The specimens from Boomerang Tank are those recorded by Lloyd (1939) and originally identified as *G. australis* by the author. This occurrence is mentioned earlier in this paper.

Localities: Boomerang Tank, 26 km (16 miles) south of Canbelago (A.M. F.38571); 5·6 km (3·5 miles) due south of Mafeesh Homestead, 9·65 km (6 miles) east-southeast of Shearlegs Tank (A.M. F.50015).

Geological Age: Late Silurian.

Calymene duni Etheridge and Mitchell

1917 *Calymene duni* Etheridge and Mitchell. *Proc. Linn. Soc. N.S.W.*, 42 (3), p. 487, pl. 24, fig. 8; pl. 27, fig. 12.

Remarks: This species was founded on two pygidia and to my knowledge has not be recorded since publication of the original description. Some years ago Dr J. Shirley examined the pygidium in the Australian Museum collection, figured by Etheridge and Mitchell (pl. 24, fig. 8) and he was of the definite opinion that it originally came from near Oslo, Sweden (pers. comm.). The recorded locality of

this specimen is Wee Jasper Crossing, Goodradigbee River, New South Wales, but was *in situ* when collected. At the time of its description the pygidium was in Mitchell's private collection which included a considerable number of foreign specimens. Later in 1933, when the collection was purchased by the Australian Museum, it was found that the pygidium was labelled "Bowning, N.S.W.", a most unlikely locality for a specimen with its type of preservation. The second pygidium (S. 533–4, Geological and Mining Museum Collection), figured by Etheridge and Mitchell (pl. 27, fig. 12) is labelled from "near Yass" and although poorly figured has little similarity with the previously mentioned pygidium which I feel must be accepted as a European species.

Family Odontopleuridae Burmeister, 1843
Subfamily Odontopleurinae Burmeister, 1843
Genus *Leonaspis* Richter and Richter, 1917
Leonaspis rattei (Etheridge and Mitchell)
Figure 3F

1887 *Acidaspis* near *A. leonhardi* Ratte (non Barr.) *Proc. Linn. Soc. N.S.W.*, 2 (2), p. 99, pl. 2, figs 2–4.

1896 *Odontopleura rattei* Etheridge and Mitchell, *Ibid.*, 10 (4), p. 699, pl. 50, fig. 7; pl. 51, figs 8–9; pl. 52, figs 1–4; pl. 53, figs 4–5.

1971 *Leonaspis rattei* Chatterton, *Palaeontographica*, 137, Abt A, p. 90, pl. 22, figs 8–14; pl. 23, fig. 14.

Remarks: A fairly well preserved cranidium (A.M. F.50058) and an imperfect impression (A.M. F.50061) are referred to this species although some of the diagnostic features are somewhat obscure.

Strusz (1964, p. 96) suggested that of the four species of *Odontopleura* described by Etheridge and Mitchell (1896) only *O. rattei* should perhaps be referred to the genus *Leonaspis*. Chatterton (1971, p. 46) listed the characters of *L. rattei*, *L. jenkinsi* and a new species *L. clavatus*, described by him, from the Warroo Limestone, Taemas Formation, 2 miles south of Hume Park, near Yass, New South Wales. This species has a number of characters in common with *L. rattei* and he suggests that it may be ancestral to *L. clavatus*.

Locality: 17·69 km (11 miles) southeast of Nymagee along the Nymagee-Hermidale Road, thence 1·6 km (1 mile) northeast.

Geological Age: Mallee Tank Beds, (?)Lower Silurian.

ACKNOWLEDGMENTS

The author wishes to acknowledge advice received from Dr Norman S. Newell, American Museum of Natural History, Dr A. A. Öpik, Bureau of Mineral Resources, Canberra, Dr E. O. Rayner, Department of Mines, Sydney, and Dr A. Ritchie, Australian Museum, Sydney. I am also indebted to Dr Ritchie for the excellent photographs of the specimens reproduced in this paper.

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Manuscript received 4th September, 1974.

FIGURE 2

Scutellum (*Scutellum*) sp. indet.

A—Dorsal view of incomplete pygidium, F.46829, ×2.

Thomastus thomastus Öpik

B—Pygidium showing general outline and doublure, anterior angles missing, F.50360, ×2.

C—A pygidium from the Roysth Limestone Member near Borenore, N.S.W. Portion of the test is missing showing the doublure, F.44318, ×2.

D—Non-testiferous pygidium, F.50358, ×2.

Harpes nymageensis sp. nov.

E—The holotype, F.50030, ×2.

Cheirurus (*Crotalocephalus*) *silverdalensis* Etheridge and Mitchell

F—Distorted glabella, F.55037, ×2.

G—Glabella with incomplete fixigenae F.55038, ×2.

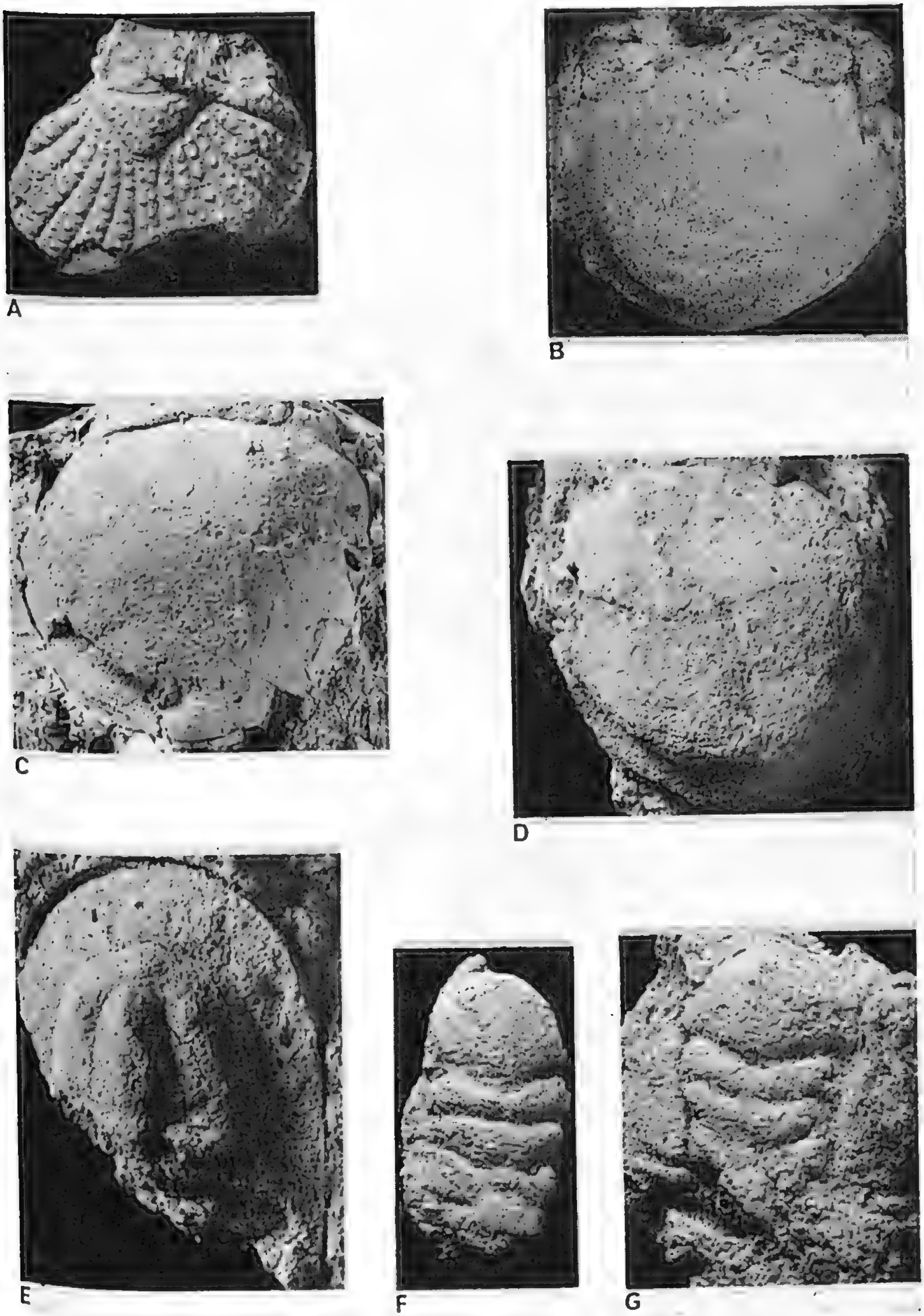
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FIGURE 3

Encrinurus mitchelli Foerste

A—Pygidium with attached thoracic segments, F.47670, ×4.

Encrinurus cf. *silverdalensis* Etheridge and Mitchell

B—Right free cheek, F.50873, ×2.
C—Left free cheek, F.47673, ×2.
D—Pygidium, F.49927, ×4.

Leonaspis rattei Etheridge and Mitchell

E—Well preserved cranidium, F.50058, ×4.

Gravicalymene angustior Chapman

F—Crushed glabella showing distorted lobes, F.38571, ×2.
G—Incomplete cranidium, F.38571a, ×2.

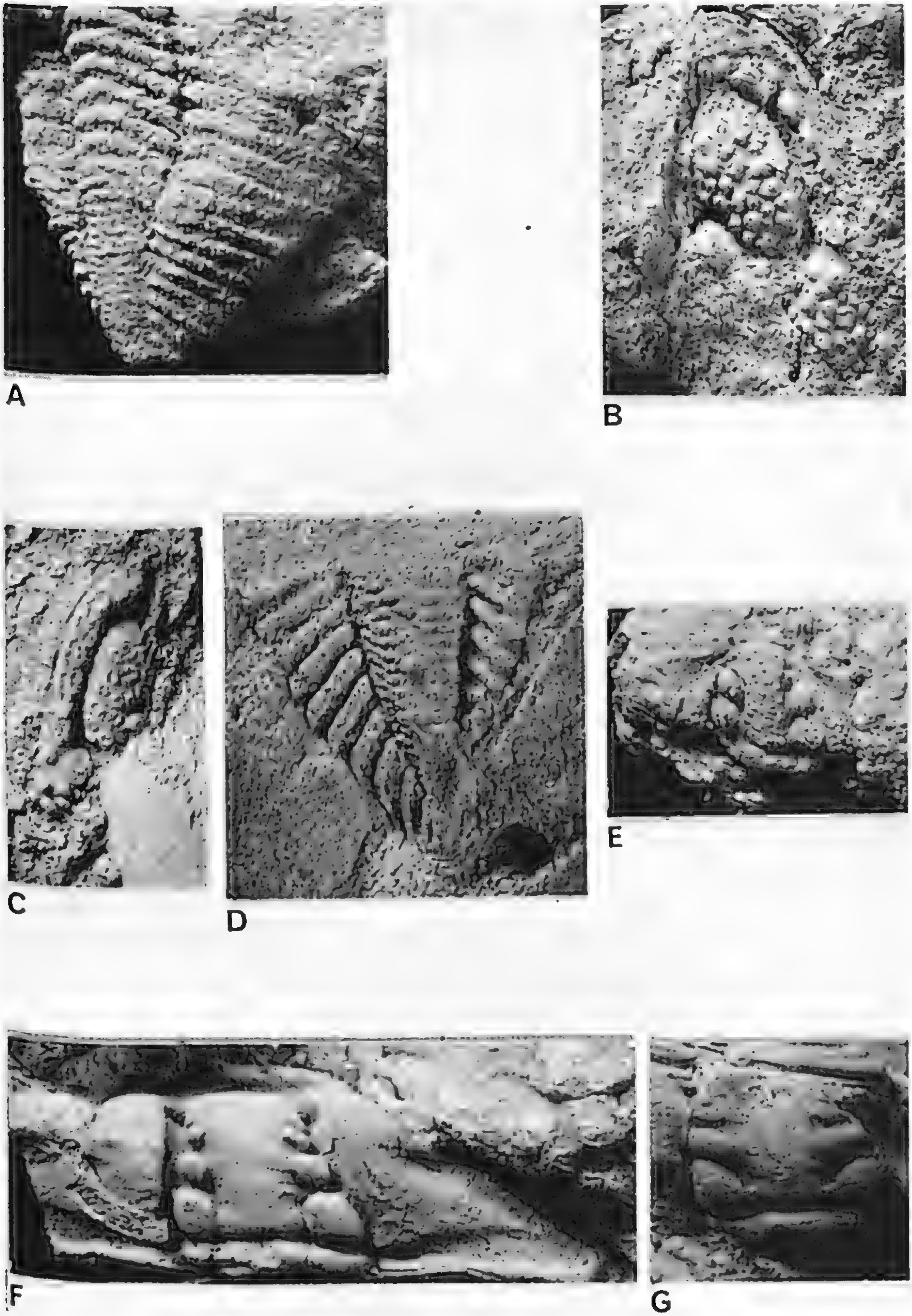
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FIGURE 4

Gravicalymene angustior Chapman

A—Incomplete cranidium showing well preserved glabella and lobes, F.50015, ×4.
B—An immature incomplete cranidium, F.50015, ×4.

Goniophora hermitagensis sp. nov.

C—Left valve of the holotype, F.47967 (nat. size).
D—Incomplete left valve (paratype), F.46822 (nat. size).

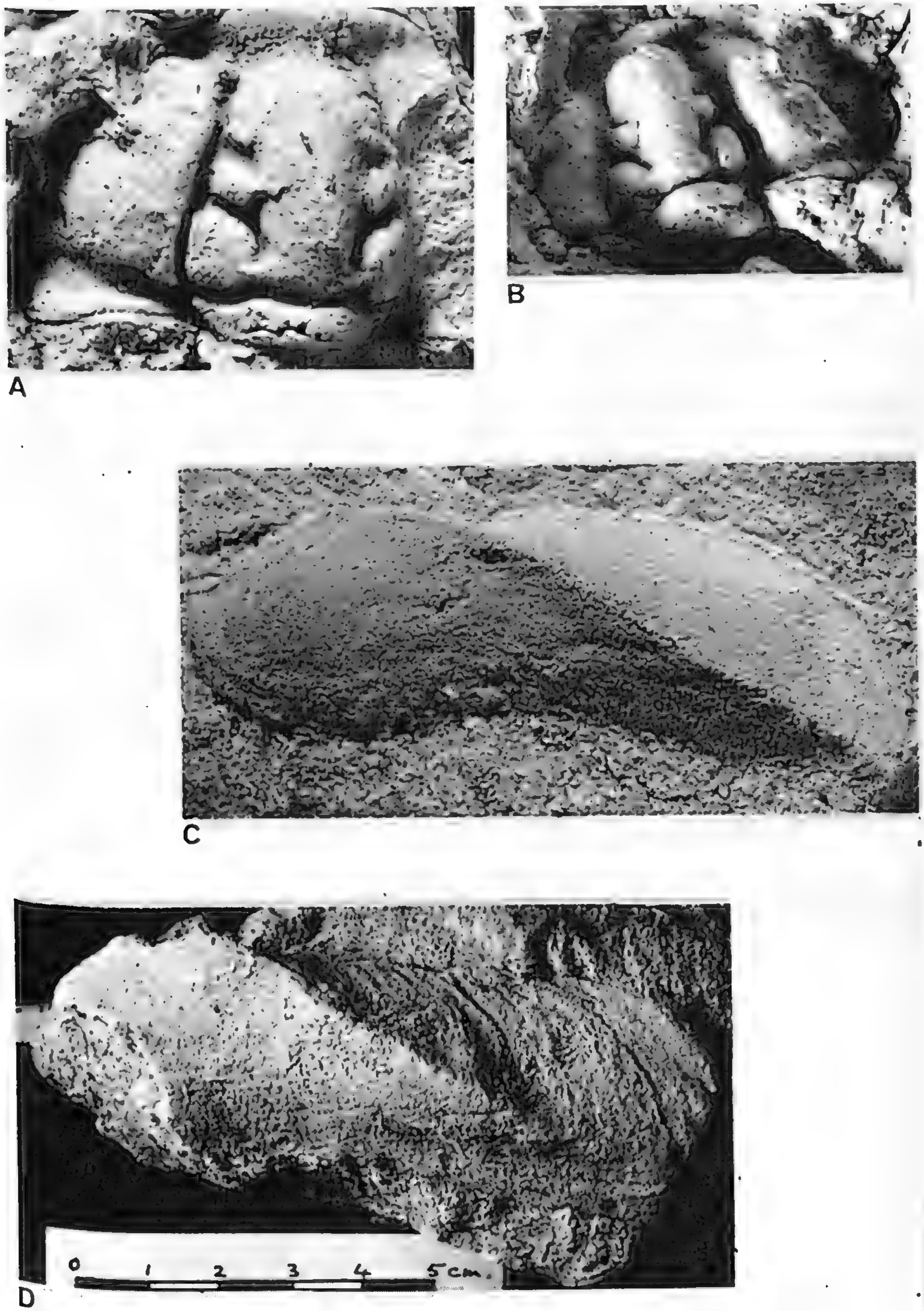
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FIGURE 5

Kochia rayneri sp. nov.

A—Dorsal view of left valve (holotype) showing general outline, F.47467 (nat. size)
B—Side view of fig. 1 showing valve curvature.
C—Front view of fig. 1 showing strongly incurved and twisted beak.
D—Side view of left valve (paratype), F.55041 (nat. size).
E—Dorsal view of fig. 4.
F—An immature valve, F.47472 (nat. size).

Encrinurus cf. *borenorensis* Fletcher

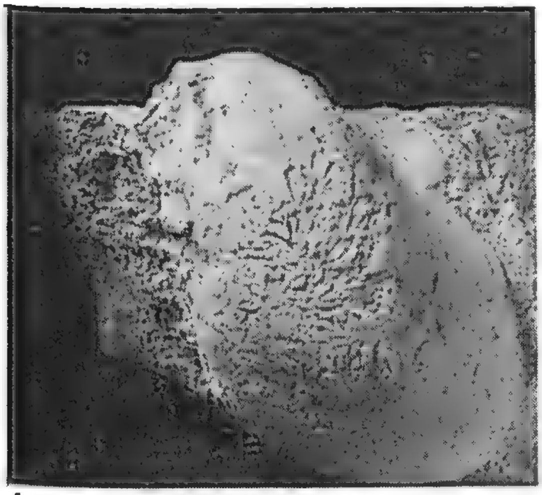
G—A poorly preserved pygidium, F.55039, ×2.

Encrinurus sp. indet.

H—Small keel-shaped pygidium, F.47729, ×3.

Encrinurus mitchelli Foerste

I—Incomplete cranidium, F.47717, ×4.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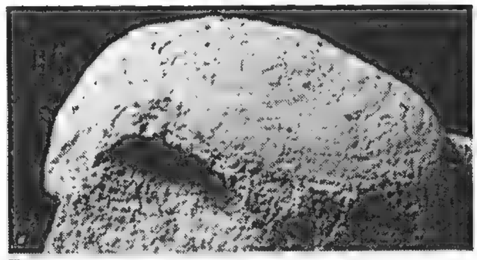
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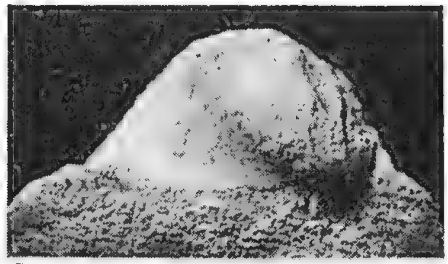
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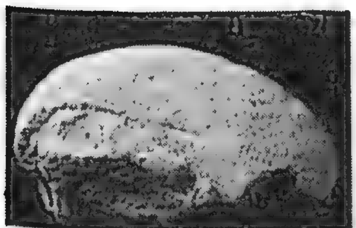
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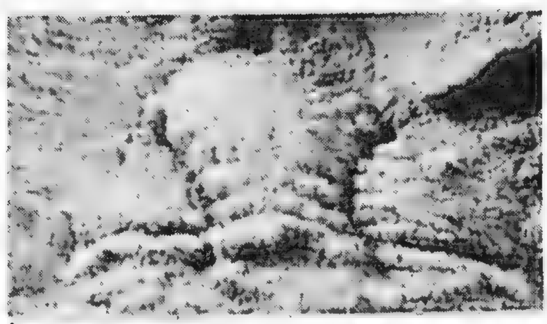
I

NEW LIZARDS OF THE GENUS *PSEUDOTHECADACTYLUS* (LACERTILIA: GEKKONIDAE) FROM ARNHEM LAND AND NORTHWESTERN AUSTRALIA

H. G. COGGER

The Australian Museum

SUMMARY

A new species and a new subspecies of the gekkonid lizard genus *Pseudothecadactylus* Brongersma are described from the western escarpment of Arnhem Land and the Kimberley region of Western Australia respectively.

The genus *Pseudothecadactylus* was previously monotypic, and the characteristics, habits, distribution and relationships of the new forms and of *P. australis* Günther are discussed briefly.

INTRODUCTION

Brongersma (1934) erected the genus *Torresia* to accommodate the large and distinctive gecko *Thecadactylus australis* Günther fιom the islands of Torres Strait. Longman subsequently pointed out that Brongersma's *Torresia* was preoccupied by *Torresia* Castelnau, 1875 (Pisces: Labridae), as a result of which Brongersma (1936) renamed his genus *Pseudothecadactylus*. This genus has remained monotypic since it was first described as *Torresia*.

In February, 1972, a series of specimens of a large new gecko was collected by B. L. Bolton and D. Lindner of the Forestry, Fisheries, National Parks and Wildlife Branch, Department of the Northern Territory, from Deaf Adder Creek, a tributary of Nourlangie Creek on the western escarpment of Arnhem Land.

Subsequently, additional specimens have been found at various localities along and adjacent to the Arnhem Land escarpment, while Dr Glen M. Storr has kindly permitted me to examine and describe specimens representing a distinctive race from near Port Warrender, Western Australia.

These distinctive geckos are clearly congeneric with *Pseudothecadactylus australis*, and are described below. The zoogeographic implications of their discovery, and a re-assessment of the distribution and status of *P. australis*, are also discussed. Measurements were made according to the criteria of Kluge (1967).

Records of the Australian Museum, 1975, 30, 87–97, figures 1–6

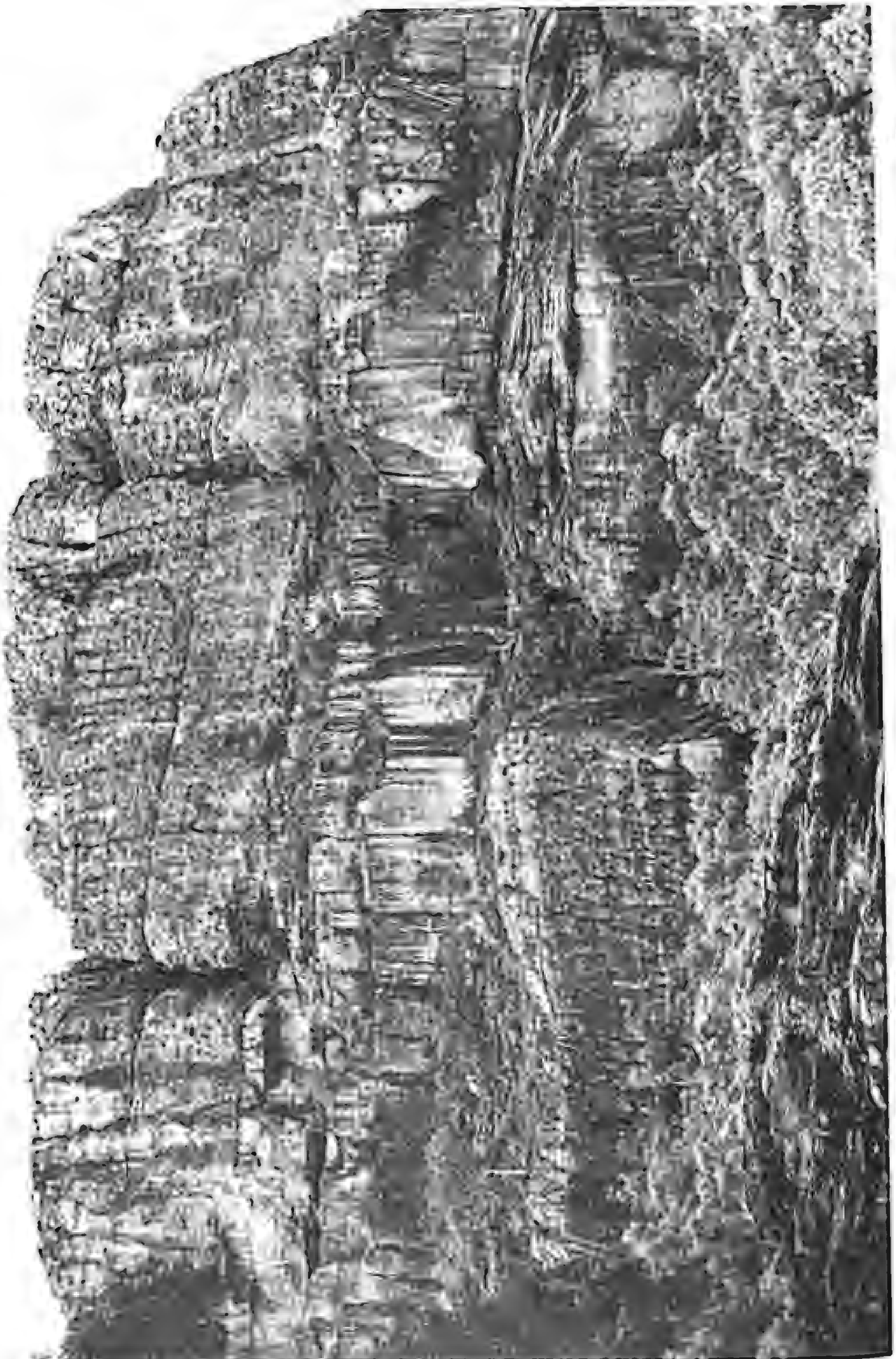

Fig. 1.—Habitat of *Pseudothecadactylus lindneri lindneri*, Mt Brockman Range, Arnhem Land, Northern Territory.

Except for the apparent absence of preanal pores in the males of one of the new subspecies, these new geckos conform in most respects to Kluge's (1967) detailed redefinition of the genus *Pseudothecadactylus.*

The species is named in honour of Mr David Lindner who, during the past decade, has done much to advance our knowledge of the composition, distribution and ecology of the fauna of the Northern Territory.

Pseudothecadactylus lindneri sp. nov.

Holotype: R38734 in the Australian Museum, an adult male collected by H. G. Cogger and D. Lindner from the vicinity of Koongarra Mining Camp, Mt Brockman Range, Northern Territory (latitude 12° 51′ S., longitude 132° 52′ E.) on 6th March, 1973.

Paratypes (24): R39522, R39895, R40283, Cannon Hill, in 12° 22′ S., 132° 56′ E.; R39493, R39975, R39992, Nourlangie Rock, Mt Brockman Range, in 12° 52′ S., 132° 48′ E.; R38730–3, R38735, R38945–6, near Koongarra Mining Camp, Mt Brockman Range, in 12° 53′ S., 132° 50′ E.; R37126–7, R37129–33, R39496–7, R39520–1, Deaf Adder Creek, in approx. 13° 05′ S., 132° 55′ E. All of the above localities are associated with the western escarpment of Arnhem Land, Northern Territory.

Diagnosis: Pseudothecadactylus lindneri, together with its congener *P. australis*, may be distinguished from all other Australian gekkonids by the combination of (1) underside of digits with a continuous and subequal series of enlarged lamellae, divided medially, and (2) a small terminal claw arising from the edge of the digital expansion (except for the inner digit, which is clawless) and which is at least partly retractile in the distal median groove. *P. lindneri* may be distinguished from *P. australis* by the reduced development or absence of preanal pores in the males (well-developed and conspicuous in *australis*); ear-opening large, at least six times as large as the nostril (as large as or slightly larger than the nostril in *australis*); scales of snout small, 20–25 scales along a median line between the rostral and a line joining the anterior edges of the eyes (large in *australis*, about 10 scales along a median line between rostral and eyes); rostral undivided, much broader than high (almost completely divided and not much broader than high in *australis*); males with 2–4 postanal tubercles on each side (a single flat tubercle on each side in *australis*); colour pattern (figs 2, 4, and 6). Diagnostic differences between the two subspecies of *P. lindneri* are cited on page 93.

Description of Holotype (Fig. 2): An adult male with a snout-vent length of 101·5 mm and a complete but reproduced tail measuring 77 mm. Orbital diameter: 6·5 mm. Eye to ear length: 9·6 mm. Head length: 28·0 mm. Head width: 21·5 mm. Axilla-groin: 44 mm. Forelimb length: 35 mm. Hindlimb length: 45 mm. Ear-opening vertically elliptic: 3·4 mm x 1·0 mm.

The head is broad and noticeably triangular in shape when viewed from above. The scales of the head are small, juxtaposed and more or less hexagonal, numbering about 38 between the supraciliaries along a line joining the centres of the eyes; the supraorbitals, interorbitals and scales on the snout are subequal, except for the enlarged labials, rostral, nasal and internasal scales. Rostral about $1\frac{1}{2}$ times as broad as deep, without any indication of a groove or crease. The

Fig. 2.—Dorsal view of holotype of *P. l. lindneri.*

nostril is narrowly separated from the rostral by an anterior nasal and (on the right side only) a minute supernumerary scale, and is in contact with the first supralabial. Above and behind it is surrounded by four or five moderately enlarged nasal scales, while there is an irregular series of internasal scales which are significantly larger than the other scales on the snout. About 18–20 loreals. Eleven enlarged supralabials and twelve infralabials on each side. Mental roughly triangular, only slightly longer than broad. A series of enlarged scales bordering the mental and anterior infralabials.

Scales on body and limbs small, flat, juxtaposed, and homogeneous, the ventrals nearly twice the size of the dorsals. Approximately 120 scales around the middle of the body. Preanal pores present but poorly developed; indeed, each of the 11 pores is visible only under high magnification as a minute opening in a preanal scale. The pores are arranged in three transverse rows of adjacent scales; the first row consists of 7 pores, the second row of 3 pores and a single pore in the third row.

Postanal region swollen, covered below by a series of enlarged scales and with a ventro-laterally placed pair of enlarged postanal tubercles or cloacal spurs on each side.

Tail long, slender, round in section, and covered by small, flat homogeneous scales except for the terminal subcaudals which are modified to form pilose lamellae (*sensu* Kluge, 1967).

The digits are strongly dilated with two continuous rows of broad, subequal transverse lamellae (fig. 3a). The inner digit of each is clawless, but in the others there is a moderate claw arising from the distal end of each digit and which appears to be at least partly retractile in the median terminal groove. The claw of each digit arises from a long high sheath which itself arises from the base of the digit and is fused along its length with the upper surface of the digit (Brongersma, 1934, figs 5–7). Fourth toe with sixteen pairs of pilose lamellae.

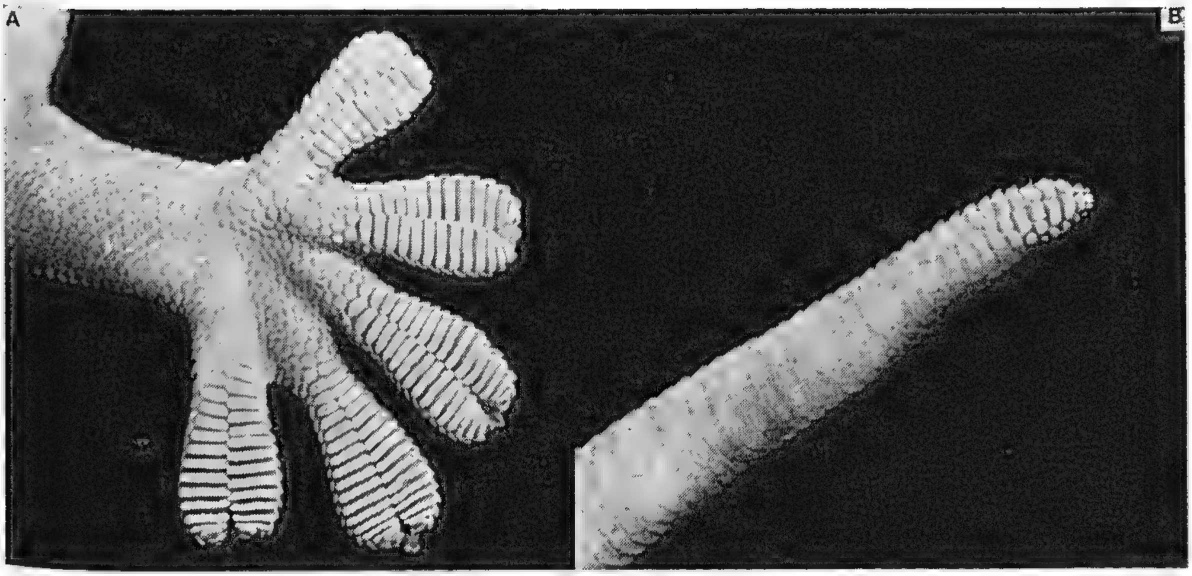

Fig. 3.—a. Lower surface of foot of *Pseudothecadactylus l. lindneri.*

b. Lower surface of tail of *P. l. lindneri*, showing pilose terminal lamellae.

Colour (in alcohol): Light creamish white with obscure dark brown reticulations on the head, body and limbs, with a tendency to form irregular broad dark brown cross-bands. Tail purplish-brown with one narrow white cross-band on the base. Ventral surfaces immaculate white.

Living specimens are purplish-brown with a series of irregular light white or cream transverse cross-bands and spots on the body (fig. 4, top). Original tails have subequal alternate cross-bands of dark purplish-brown and yellow. Limbs and head above with irregular cream-coloured flecks, and darker brown variegations. Ventral surface white or, more frequently, very lightly pigmented with purplish-brown, especially on the limbs, throat and tail. Iris bright yellow or reddish orange.

Variation: Little variation in scalation or colour pattern was observed in the paratype series. The largest specimen has a snout-vent length of 107 mm, while the following dimensions are expressed as percentages of snout-vent length: tail length 68·5–98·8 (mean 83·3); head length 26·8–28·4 (mean 27·7); head width 20·6–22·3 (mean 21·4); axilla-groin 40·3–48·2 (mean 44·3); forelimb length 33·0–40·0 (mean 35·9); hindlimb length 42·0–51·1 (mean 46·3); eye-ear 9·1–10·0 (mean 9·5); orbital diameter 6·2–7·1 (mean 6·5).

Mid-body scale rows 111–130 (mean 121·4), interorbitals 32–38 (mean 35·1), preanal pores 6–13 (mean 8·7).

Although pores are obscurely present in the holotype, only in one paratype (R39496) are the pores reasonably well-developed. In this specimen the protruding exudate from each pore clearly marks its position, so that a single curved, median transverse series of seven pores is present about seventeen scales anterior to the vent. In the remaining paratype males the pores are obscure to microscopic, numbering from two (R40283) to thirteen (R38732); in this specimen one scale has two pores.

Fig. 4.—Top: Living specimen of *Pseudothecadactylus l. lindneri* from the type locality.
Bottom: Living specimen of Pseudothecadactylus australis.

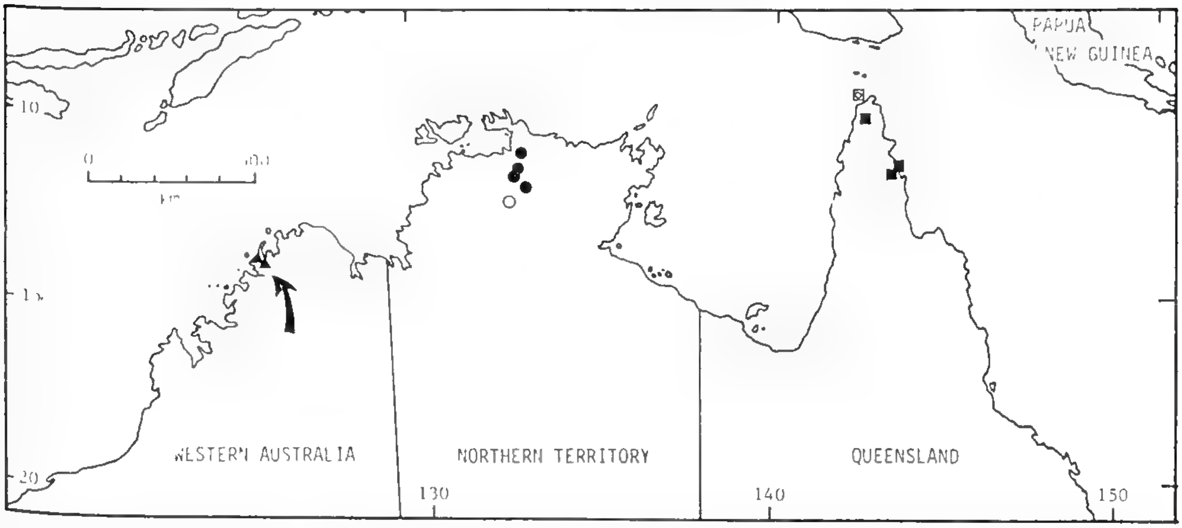

Fig. 5.—Distribution of species of *Pseudothecadactylus*. Solid symbols: specimens examined; open symbols: literature records or unconfirmed sightings.

■ □ *Pseudothecadactylus australis*

● ○ *Pseudothecadactylus lindneri lindneri*

▲ *Pseudothecadactylus lindneri cavaticus*

Distribution: Specimens have been seen or collected from various localities associated with the western escarpment of Arnhem Land (see list of paratypes). All known records for *Pseudothecadactylus* are plotted in figure 5.

Pseudothecadactylus lindneri cavaticus subsp. nov.

Holotype: R43176 in the Western Australian Museum, an adult male collected by L. A. Smith and R. E. Johnstone near Mitchell River Falls, approximately 25 km southwest of Crystal Head, Port Warrender, Western Australia (approx. 14° 40′ S., 125° 42′ E.) on 14th January, 1973.

Paratypes: R43175 (adult female) and R43137 (subadult male) in the Western Australian Museum; the former with the same data as the holotype, the latter from Surveyors Pool, Mitchell Plateau (in 14° 40′ S., 125° 44′ E.), approximately 15 km southwest of Crystal Head, Port Warrender, Western Australia, collected by L. A. Smith and R. E. Johnstone on 17th February, 1973.

Diagnosis: Distinguished from the nominate subspecies by its possession of moderately heterogeneous dorsal and lateral scales (homogeneous in *Pseudothecadactylus l. lindneri*) and its colour pattern (*see* fig. 6). In all specimens of *P. l. lindneri* so far examined, the rostral is excluded from the nostril, whereas the three types of *P. l. cavaticus* each has the rostral narrowly contacting the nostril (narrowly separated on one side in WAM R43137).

Fig. 6.—Dorsal view of holotype of *P. l. cavaticus*.

Description of Holotype (fig. 6): An adult male with a snout-vent length of 115 mm and a complete but reproduced tail measuring 76 mm. Orbital diameter: 7·2 mm. Eye to ear length: 102 mm. Head length: 31·9 mm. Head width: 23·8 mm. Axilla-groin: 52 mm. Forelimb length: 39 mm. Hindlimb length: approximately 50 mm. Ear-opening vertically elliptic, 5·4 x 2·4 mm.

Similar in most respects to the holotype of *Pseudothecadactylus lindneri lindneri*, except that the rostral narrowly contacts the nostril, while the dorsal and dorso-lateral scales are moderately heterogeneous (fig. 6). The largest dorso-laterals are distinctly tubercular and about twice as large as the mid-dorsals, while the latter are scarcely larger than the lower laterals.

There are about 38 scales between the supraciliaries along a line joining the centres of the eyes, while there are approximately 119 scales around the middle of the body. There are about 20–22 loreals, 11 enlarged supralabials and 12 infralabials on each side, and two moderately-enlarged flat postanal tubercles on each side of the swollen postanal region. There are 19 pairs of enlarged, pilose lamellae under the fourth toe. Although some preanal scales have faint depressions, there are no indications of preanal pores.

In alcohol, the top of the head is marbled with dark purplish-brown and pale, drab vinaceous-brown. The body has a series of six or seven irregular, pale drab vinaceous-brown cross-bands alternating with subequal cross-bands of dark purplish-brown. The paler bands tend to have darker centres. Limbs above marbled with the two colours. Venter white. Tail dark brown with lighter flecks.

Variation: Only the female paratype possesses an original tail, on which seven or eight irregular dark brown cross-bands alternate with about nine irregular, somewhat wider pale brown to cream cross-bands while the terminal twelve to fourteen distal subcaudal scale rows possess pilose surfaces. The dimensions and scalation (of the adult female and subadult male paratypes respectively) are as follows, all dimensions but snout-vent length expressed as percentages of snout-vent length: Snout-vent length 106 mm, 88 mm; tail length 92·4, 65·9; head length 29·1, 29·1; axilla-groin 39·6, 43·2; forelimb length 34·9, 36·4; hindlimb length 48·1, 51·1; eye-ear 10·5, 10·2; orbital diameter 5·7, 6·2. Mid-body scale rows approx. 114, approx. 104; interorbitals approx. 35, approx. 33. The subadult male also lacks preanal pores.

DISCUSSION

Brongersma (1934) diagnosed those features differentiating *Pseudothecadactylus* (as *Torresia*) from *Thecadactylus*; similarities between these two genera are doubtless superficial and the result of convergence. Kluge (1967) has shown that whereas *Thecadactylus* is a gekkonine genus, *Pseudothecadactylus* clearly belongs in the subfamily Diplodactylinae. The characteristics of the present species confirm the diplodactyline affinities of the genus, although there are superficial similarities between *Pseudothecadactylus* and some species of the gekkonine genus *Gekko*.

Preanal pores are poorly-developed or absent in *Pseudothecadactylus lindneri*. However, in *P. australis* there is a distinctive triangular patch of preanal pores in the males (the number could not be ascertained in the specimens examined as a

patch of skin, including pores, has been removed from each male). The only diplodactyline genera in which preanal pores may be present in some species but not in others are *Oedura* and *Diplodactylus*. Hence *Pseudothecadactylus* is the only member of the Kluge's (1967) tribe Carphodactylini in which there is interspecific variation in the presence or absence of pores.

Except for the absence or poor development of preanal pores in the males, the new species conforms closely to Kluge's (1967) detailed redefinition of *Pseudothecadactylus*. The skull is distinctly ornamented on the snout. The nasal process of the premaxilla is not short and very wide as described by Kluge, but moderate, being decidedly longer than broad. In the three skeletal preparations examined the premaxillae are paired and the maxilla and prefrontal are broadly in contact. The lateral and medial infraorbital processes of the prefrontal are well developed. The number of scleral ossicles ranged from thirty-five to thirty-six. The jugal is approximately three to four times longer than wide, and is extensively overlapped by the infraorbital processes. The clavicles are considerably dilated, thin, and with large fenestrae. Kluge (1967) describes the interclavicle of *P. australis* as moderate, with a small posterolaterally directed process widely separated from the clavicle; in *P. lindneri* the interclavicle is shield-shaped with either one or two lateral processes on each side. In one of the skeletal preparations examined there is an abnormal arrangement on the lizard's left side whereby a process projects from the rear edge of the clavicle to articulate with the inter-clavicle. There are three sternal ribs on each side (Kluge cites two on each side for *P. australis*), two xiphisternal (mesosternal of Kluge) ribs on each side and no xiphisternal extension. Poststernals number 12, with the anterior pairs almost meeting along the midline. The phalangeal formulae are 2.3.4.5.3. (hand) and 2.3.4.5.4. (foot). These features, together with those external morphological ones described above, leave little doubt that *lindneri* is correctly associated with *australis* in the genus *Pseudothecadactylus*.

Although the tail of *P. lindneri* is virtually identical in form and structure to that of *P. australis*, it is only moderately prehensile, as is also said to be the case in *P. australis* (Kluge, 1967). The terminal subcaudals, especially of original tails, are modified to form lamellae in *P. lindneri* (fig. 3b).

The original series of specimens of *P. l. lindneri* were taken ". . . under overhanging boulders in drizzly weather between 2000 and 2100 hours in typical Kombolgie sandstone of the western Arnhem Land plateau" (D. Lindner, *pers. comm.*). Subsequently, specimens were taken in similar habitats (viz. among caves, crevices, overhangs and massive boulders) under a variety of climatic conditions at Cannon Hill, Nourlangie Rock and Koongarra (Mt Brockman Range) and the Deaf Adder Creek gorge. The gecko consistently proved to be most active and abundant in showery or drizzly weather. The characteristic habitat is shown in fig. 1. Several gravid females each contained two well-developed eggs.

Little is known of the habits or ecology of *P. australis*. Indeed the only habitat data available are those for several specimens collected in Cape York Peninsula by the 1948 Archbold Expedition of the American Museum of Natural History. Each specimen was collected at night while the collectors were spotlighting for mammals (H. Van Deusen *pers. comm.*). A series of specimens was taken by P. Webber and E. Cameron (*pers. comm.*) on Prince of Wales Island, Torres Strait, in February, 1975; these were found associated with paperbark swamps on the northwestern side of the island.

The geckos were found in hollows in the upright trunks and limbs of *Melaleuca cajuputi*, principally associated with the transition zone between stands of bloodwoods (*Eucalyptus polycarpa*) and the paperbark swamps in which *Melaleuca viridiflora* was dominant.

P. australis is vocal, and most specimens were located during the day when they responded to the presence of a collector with a low, prolonged, grating call.

Known locality records for both *P. australis* and *P. lindneri* are plotted in fig. 5, in which their restricted and widely separated ranges are indicated.

The limited total range of the genus, its habitat specificity, its disjunct distribution and high degree of morphological differentiation of its two component species and, finally, the strong differentiation of the genus, morphologically, from other diplodactyline genera, all suggest that:

(a) the members of the genus are ecologically highly specialized;

(b) the present total range is now more restricted than it once was (i.e. the two component species may be regarded as relict forms);

(c) the genus is phyletically "old" within the *Diplodactylinae*; and

(d) the geographical origin of the genus was probably within the limits of its present range.

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MORPHOLOGICAL AND GEOGRAPHIC VARIATION OF *PSEUDOPHRYNE CORROBOREE* (ANURA: LEPTODACTYLIDAE)

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SUMMARY

The toadlet *Pseudophryne corroboree* is confined to the mountains of southeastern New South Wales and the Australian Capital Territory. The first detailed distribution map is presented. The species ranges from Mt Kosciusco in the south to the Brindabella Range near Canberra in the north. The Brindabella Range populations are isolated from those in the south. The species has not been found below 1,040 m. Its range may, in part, be limited by competitive interactions with the closely related *P. dendyi*.

P. corroboree has only a single phalanx in the first toe. In this it differs from all other Australian leptodactylids except *P. guentheri* in which the condition probably evolved independently.

Geographic variation in coloration is briefly described. The adaptive significance of this variation is not clear.

Univariate analysis of morphometric variation (ten characters, four populations) shows that Brindabella Range individuals are larger bodied than those from the Snowy Mountains area. Furthermore, there are indications of clinal (altitudinal) trends in some variables. Discriminant function and Q-mode multiple factor analyses elucidate and confirm these patterns and separate altitudinal and ontogenetic components of variation within and between populations. Large body size in specimens from the Brindabellas may be an adaptation to the size of sympatric *P. dendyi* rather than a response to ecogeographic factors.

INTRODUCTION

The toadlet, *Pseudophryne corroboree*, with its striking pattern of black and yellow dorsal stripes, occurs only in the mountains of southeastern New South Wales and the Australian Capital Territory. First described by Moore (1953), the type specimen, R13103 is in the Australian Museum. Colefax (1956), Jacobson (1963),

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Martin (1967), and Watson and Martin (1973) discussed aspects of the adult and larval morphology, habits, and development of this species. Pengilley (1971 a, b) described the reproductive behaviour and feeding habits of a single population in detail. In this paper, I report a previously unobserved morphological feature of this species, provide the first detailed distribution map, and describe and discuss the nature of geographic variation in size and coloration in the samples examined.

METHODS

Descriptions of adult morphology are based on the study of live and preserved material in the collections of the Australian Museum, the National Museum of Victoria, and the Department of Zoology, University of Melbourne. Ninety-five adults were examined. Morphometric measurements (to 0·1 mm) were taken on males (known to have been collected from breeding aggregations) preserved in 70 per cent alcohol, using vernier calipers and an ocular micrometer. Ten measurements were taken on each specimen: the lengths of the body, head, tibia, foot, and each toe, and the width of the head. Body length is the snout-vent distance. Tibia length is the distance from the centre of the knee to the centre of the heel, measured with the leg flexed. Foot length is the distance from the tip of the fourth toe to the near edge of the outer metatarsal tubercle. Head length is the distance from the corner of the mouth to the tip of the snout, measured ventrally. Head width is measured ventrally at the level of the corners of the mouth. Toe length is the distance from the tip of the toe to the midpoint of the proximal end, viewed dorsally. Skeletal features were investigated by X-radiography using Nippon Softex apparatus.

Morphometric data were processed at the computer centres of the University of Melbourne and Harvard University. The stepwise discriminant analysis was performed with the BMDO7M health services computing facility (U.C.L.A.) programme. The Q-mode multiple factor analysis was performed with the Columbia-Alberta factor analysis (CABFAC) programme written by J. Imbrie and E. Klovan.

DISTRIBUTION

Pseudophryne corroboree has been found at 17 localities in southeastern N.S.W. and the Australian Capital Territory (figure 1). The Australian Museum has specimens from the Brindabella Range; Alpine Hut, Mt Kosciusco; Round Mountain; Smiggin Holes; and Happy Jacks Plain. The National Museum of Victoria has a sample from Pretty Plain. Melbourne University has specimens from Smiggin Holes and six localities in the Brindabella Range: 9·6 and 1·6 km S. of Bulls Head; Lees Spring; 1·6 km SE. of Mt Franklin Chalet; Ginini Flat; and Snowy Flat on Mt Gingera. There are five literature records: Coree Flat, 3·2 km N. Smiggin Holes, and 2 km SE. Yarrangobilly (Pengilley 1971a, 1973); between Island Bend and Smiggin Holes, and at Fifteen Mile, about 8 km N. of Round Mountain (Colefax 1956).

The geographic range is somewhat linear in shape extending about 160 km in a north–south direction. The range appears to be divided into two parts. The northern populations in the Brindabella and Fiery Ranges appear to be isolated from those further south. For convenience these southern populations will be referred to in this paper as from the Snowy Mountains area. The intervening country is of difficult access, and exploration between Kiandra, Youak, and Gudgenby may lead to the discovery of intermediate populations.

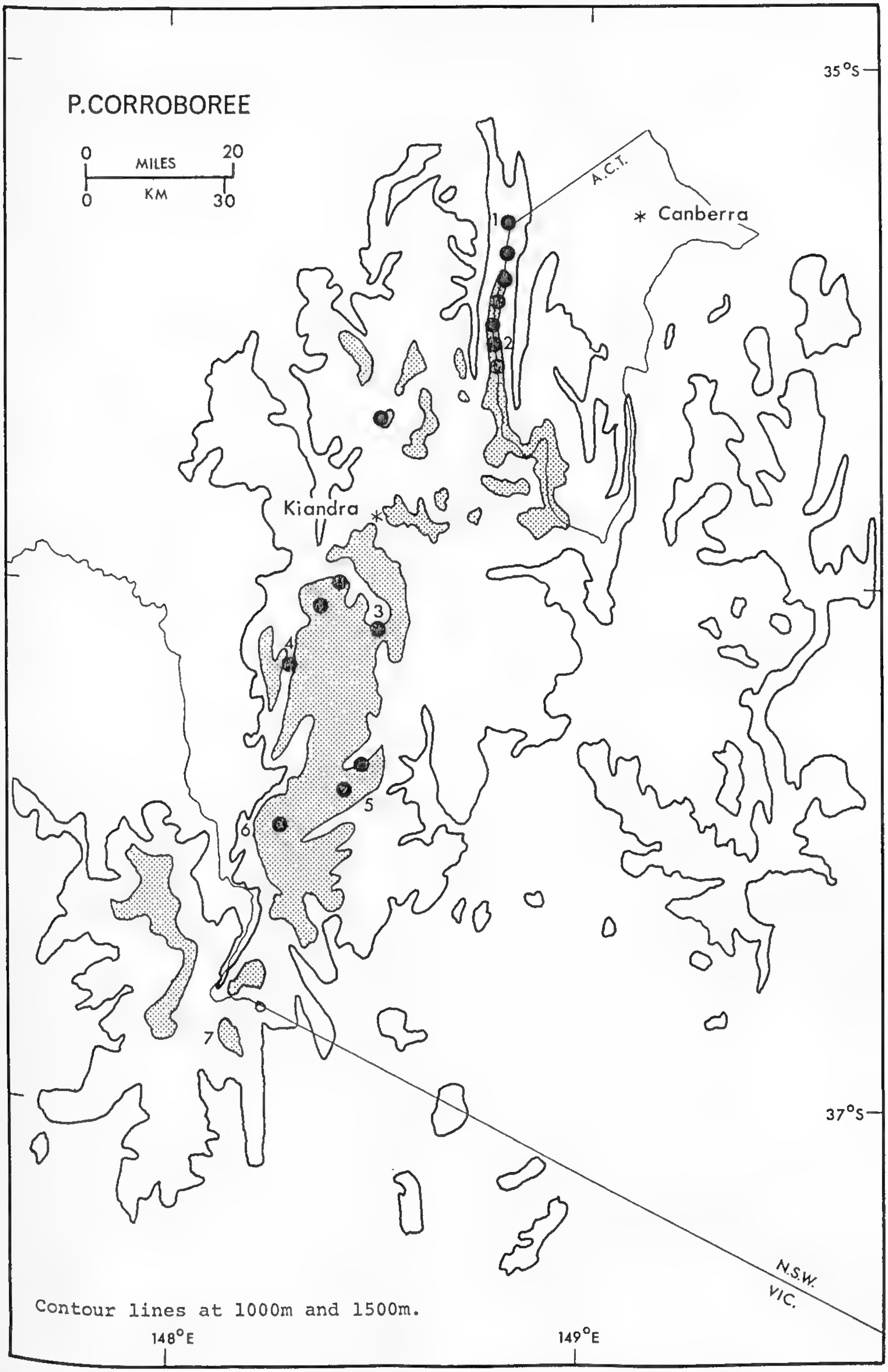

Figure 1. Distribution of *P. corroboree*. The following localities of special interest are shown: (1) Coree Flat, Brindabella Range; (2) Ginini Flat, Brindabella Range; (3) Happy Jacks Plain; (4) Pretty Plain; (5) Smiggin Holes; (6) Mt Kosciusco; (7) Mt Cobberas, Victoria.

The range of *P. corroboree* is circumscribed by that of a related species, *P. dendyi*, from which it differs strikingly in coloration and morphology (Woodruff 1972). The possibility that the distributional limits of *P. corroboree* may be determined, in part, by its interactions with *P. dendyi* is discussed below.

The southern limit of *P. corroboree* is Mt Kosciusco. *P. dendyi* occupies the Murray River valley further south and west: specimens have been taken at Tom Groggin and Cowombat. Despite occasional reports to the contrary (e.g. Fleay 1963: 407) *P. corroboree* has not yet been found in Victoria. In the subalpine bogs on Mt Cobberas, about 32 km south of Mt Kosciusco (and perhaps the most likely place to find this species if it occurred in Victoria), I found breeding choruses of *P. dendyi* during January, 1967. Searches for *P. corroboree* have also been made further west on the Bogong High Plains, the Dargo High Plains, the Mt Buffalo Plateau, and in the Mt Wellington area, but no *P. corroboree* have been found there (Woodruff 1959; Littlejohn 1965).

The northern limit of this species is near Mt Coree in the Brindabella Range. *P. corroboree* has not been found below 1,040 m at Coree Flat. In view of its apparent preference for alpine and subalpine habitats it is unlikely to occur further north. *P. dendyi* also occurs in the Brindabella Range and the two species are sympatric at Coree Flat and Lees Spring, the two northernmost localities shown in figure 1. Thus, both environmental and biotic factors may affect the position of the species border in this area.

MORPHOLOGY

X-radiography of six adults from the Brindabella Range and one from Smiggin Holes in the Snowy Mountains revealed that *P. corroboree* has only a single phalanx in the first toe (figure 2). In this feature it resembles *P. guentheri* from Western Australia but differs from all other *Pseudophryne*. I found that *P. australis*, *P. bibroni*, *P. coriacea*, *P. dendyi*, *P. occidentalis*, and *P. semimarmorata* all possess two phalanges in the first toe, as do *P. douglasi* (Main 1964) and *P.* (previously *Metacrinia*) *nichollsi* (Blake 1973).

Moore's (1961) account of morphology and coloration may be supplemented with the following observations. As in most other members of the genus, post-femoral and inguinal glands are present. In *P. corroboree* they are inconspicuous. The dorsal pattern of coloration is more variable than Moore observed in his smaller sample. The central dorsal stripe may be either black or yellow. In some specimens the stripes (particularly the lateral ones) are broken. The top of the head may bear a single large yellow patch, or it may be mottled with smaller yellow patches. In some individuals the pale patches on the ventral surfaces may be a yellow or blue colour in life. The latter colour fades in alcohol.

Comparison of live specimens from the Snowy Mountains area with those from the Brindabella Range indicates that there are regional differences in coloration. There is a decrease in the amount of yellow pigmentation in the northern populations: individuals from the Brindabella Range have less yellow on the dorsal and ventral surfaces than specimens from around Smiggin Holes. There is usually a light patch on the back of the hand; invariably yellow in the specimens from the Snowy Mountains area but usually white in those from the Brindabella Range.

Figure 2. *Pseudophryne corroboree.* X-radiograph of the right foot of a male (Melbourne University Zoology Department No. 182/64) from Ginini Flat, Brindabella Range. The first (shortest) toe has only one phalange.

Small samples of adult males from four localities (Snowy Mountains: Smiggin Holes, Happy Jacks Plain, and Pretty Plain; Brindabella Range: Ginini Flat) were measured. The variation in the ten characters studied is summarized in figure 3. Preliminary univariate analyses indicated that the three samples from the Snowy Mountains were not significantly different from one another (at the $P > 0{\cdot}05$ per cent level) with respect to each of the variables. The pooled samples from the Snowy Mountains area were significantly different, however, from the Brindabella Range sample with respect to two variables; the northern sample had significantly longer bodies and shorter tibias. Variation in these two characters was non-overlapping and the magnitude of this difference is strikingly brought out in the tibia length/body length ratio:

Snowy Mountains area (N = 27)	0·29–0·34 (mean: 0·31)
Brindabella Range (N = 7)	0·22–0·24 (mean: 0·23)

The differences in the means of the northern and southern samples are not significantly different with respect to the other eight variables. There are, however, some most interesting trends in interpopulation variation which emerge when the data are examined for variation along an altitudinal gradient. The samples are arranged in such an order in figure 3: Smiggin Holes (1,650 m), Ginini Flat (1,585 m), Happy Jacks Plain (1,460 m), and Pretty Plain (1,300 m). Mean values for body length, head width, and the lengths of toes 1–4 all increase slightly with increased altitude. Mean values for head length and the length of the fifth toe, on the other hand, decrease slightly with increasing altitude. These trends are clearer if one considers just the three samples from the Snowy Mountains area.

These patterns of variation are not satisfactorily established on the basis of these univariate analyses. Multivariate analyses were therefore performed to investigate the overall pattern of intraspecific variation in size and shape and to determine the morphometric affinities of the four samples.

The results of the stepwise discriminant function analysis are shown graphically in figure 4. The group centroids and the thirty-four individual specimens are plotted against the first two canonical axes. The first canonical variate accounts for 81 per cent of the total variation, the second variate takes up an additional 16 per cent. Together these two axes account for fully 97 per cent of the total variation in the pooled data. The individual specimens are seen to be clustered around the group centroids and only a single specimen is misclassified by formal group classification based on the computed discriminants. The first canonical axis is interpreted as a general size axis. It clearly separates the large males from the Brindabella Range from the smaller Snowy Mountains area animals. Furthermore the centroids of the three Snowy Mountains area samples also separate out in order of decreasing size. More interesting is the pattern developed by the second canonical variate which apparently reflects altitudinal variation. The position of the Happy Jacks Plain sample between the Smiggin Holes and Pretty Plain samples corresponds closely to its altitude relative to the other two. The overall pattern also indicates that the Brindabella Range population has diverged morphometrically from those of the Snowy Mountains area. The close relationship between the Happy Jacks Plain and Pretty Plain samples is probably a reflection of their geographic proximity. Overlap between members of the four samples is minimal, and occurs only in the case of the Happy Jacks and Pretty Plain samples. I conclude that both geographic and altitudinal components of variation are present but confirmation requires the measurement of additional samples from the Brindabella Range.

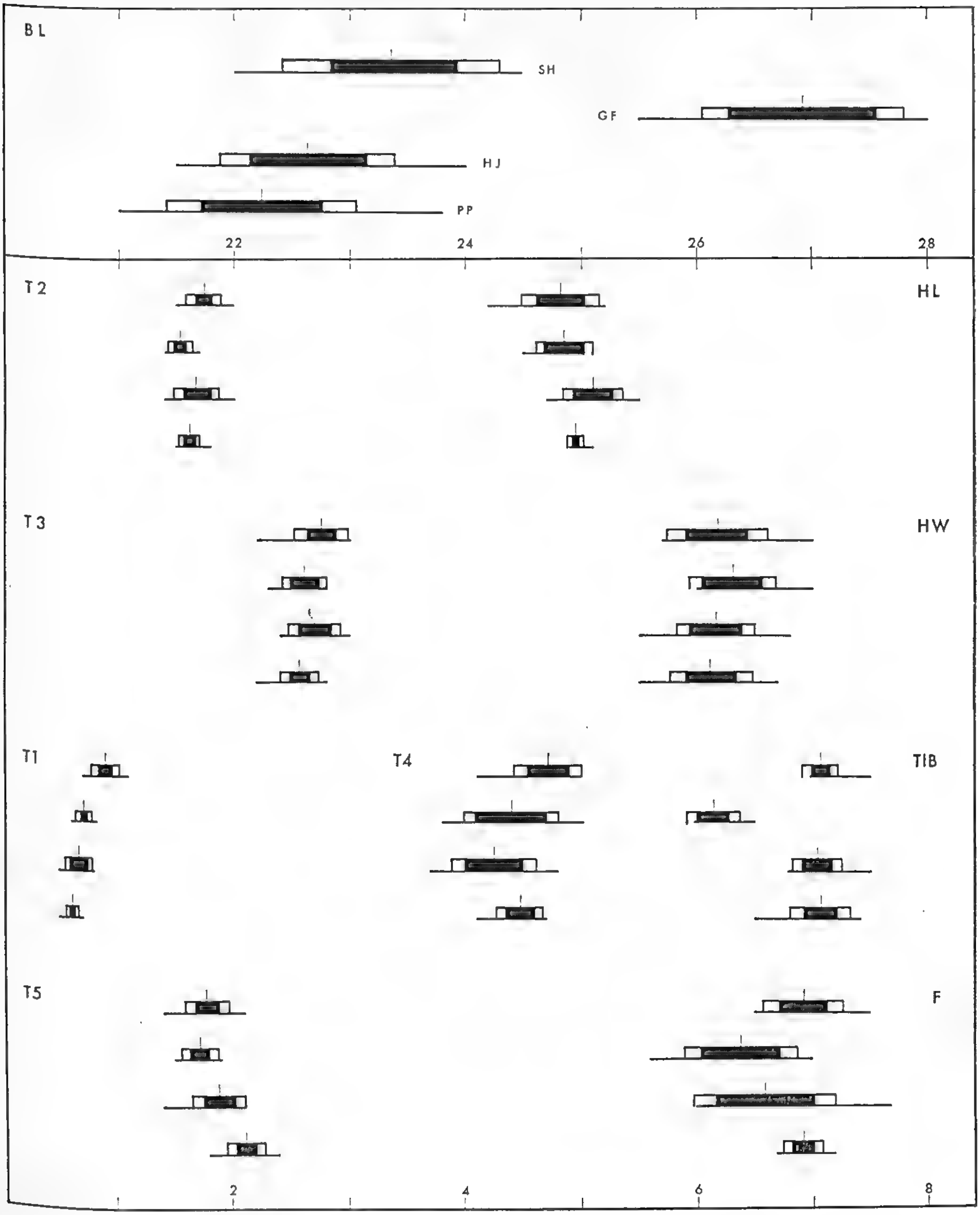

Figure 3. Geographical variation in size of four populations of *P. corroboree.* The data are for adult males and the samples are arranged in order of decreasing altitude: (SH) Smiggin Holes, N = 10; (GF) Ginini Flat, N = 7; (HJ) Happy Jacks Plain, N = 8; (PP) Pretty Plain, N= 9. The samples are compared with respect to ten morphometric variables: (BL) body length; (T1)–(T5) length of toes 1–5; (HL) head length; (HW) head width; (TIB) tibia length; and (F) foot length. Measurements are in mm. The method of graphical display employed is described by Hubbs and Hubbs (1953). For each sample the range is shown by the lower horizontal line; the mean by the vertical line; the solid rectangle encloses two standard errors of the mean on either side; and the open rectangle plus half the solid rectangle indicates one standard deviation on either side of the mean.

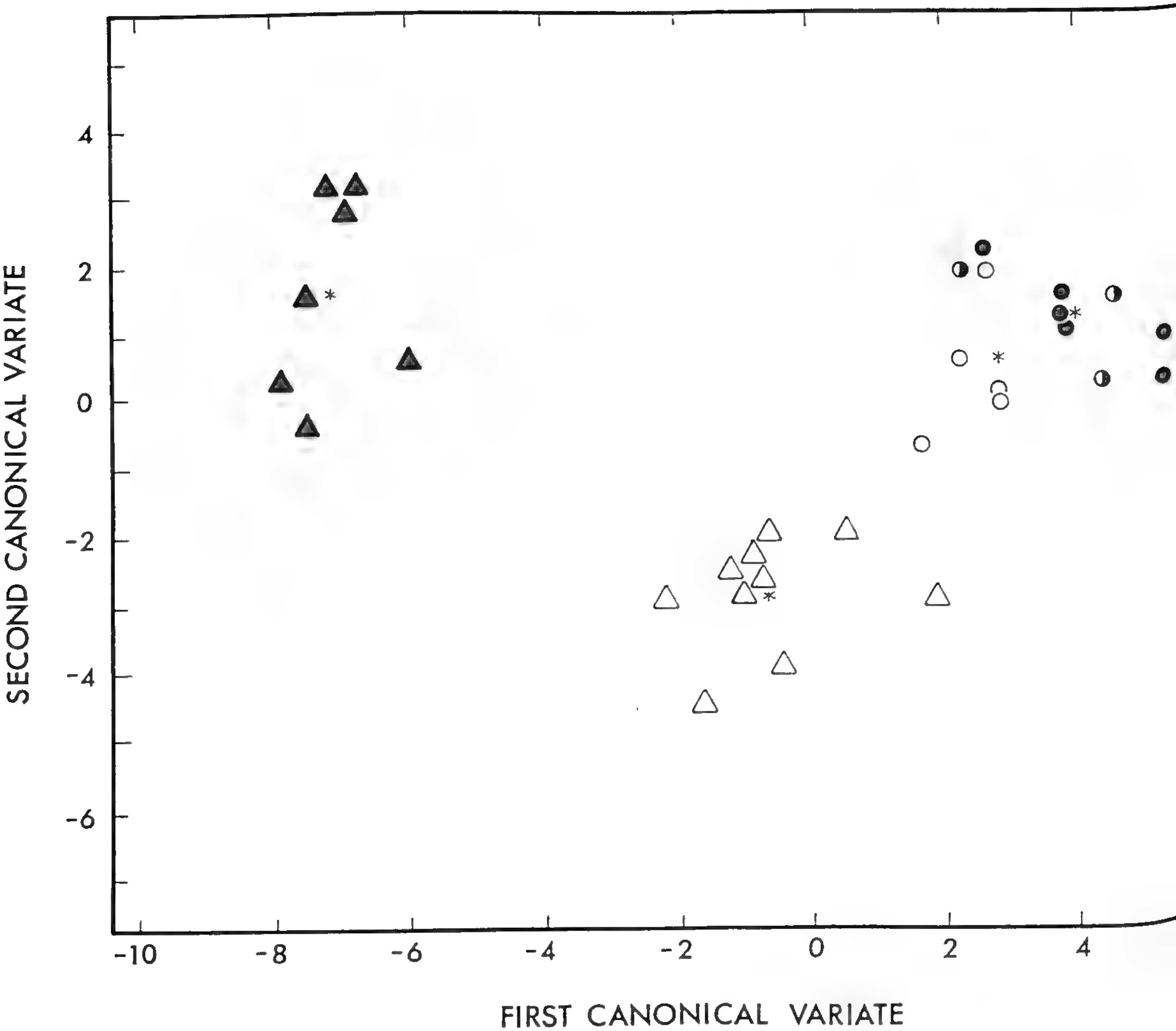

Figure 4. Canonical variate chart for the four samples of male *P. corroboree* described in figure 3. The asterisks indicate sample centroids. The symbols indicate the positions of individual specimens. Open triangles represent specimens from Smiggin Holes; closed triangles, Ginini Flat; open circles, Happy Jacks Plain; closed circles, Pretty Plain. Three cases of overlap between Happy Jacks and Pretty Plain individuals are indicated by half closed circles.

In the Q-mode multiple factor analysis the four samples are pooled. The data for each of the ten variables are first transformed to per cent range and then normalized. In this procedure, which has been described by Imbrie and Van Andel (1964), each variable receives "0" for the lowest value, "100" for the highest value, and the remaining values are expressed on the same scale. Q-mode varimax factor matrices are then calculated. It was found that the first two axes account for nearly 89 per cent of the total variation. A factor score matrix indicates the contribution of each original variable to variation along these axes (table 1). Factor loadings are then determined for each specimen and the results are shown graphically in figures 5 and 6. Instead of using the two varimax factors as the axes of a single graph (as in Gould, 1967) I have plotted the variation against each axis separately. This allows me to impose an order on the original samples. In each figure, I have arranged the samples in order of decreasing altitude, and within each sample the specimens are arranged in order of decreasing body length. The CABFAC programme can plot these results automatically.

TABLE 1. Factor Score Matrix

Body length	—0·220	0·717
Tibia length	0·628	—0·235
Head width	0·052	0·420
Head length	0·275	0·240
Toe 1 length	0·092	0·281
Toe 2 length	0·271	0·046
Toe 3 length	0·259	0·251
Toe 4 length	0·310	0·201
Toe 5 length	0·329	0·066
Foot length	0·355	0·085

Variation along the first varimax factor axis (figure 5) is due primarily to the length of the hind limb, as measured by the length of the tibia, foot, and toes 2–5. The Brindabella Range sample has relatively shorter limbs than the samples from the Snowy Mountains area. Within each of the Snowy Mountains area samples it is clear that larger individuals have relatively shorter hind limbs. This raises the important point that this form of multiple factor analysis elucidates the ontogenetic component of variation. This pattern is confused in the Brindabella Range sample by the inclusion of specimen 17. (The anomalous position of specimen 17 results from the fact that this individual has unusually short tibia, foot, and second toe. Its short body relative to the other specimens from this locality (Ginini Flat) suggests that despite its collection from a breeding chorus it may be subadult.)

Variation along the second varimax factor axis (figure 6) is due primarily to variation in body length and head width. Again we see the striking ontogenetic trend within each sample, and a clear separation of the Brindabella Range sample from the others. The northern specimens have much longer bodies than could be anticipated on the basis of the established altitudinal variation within the Snowy Mountains area. Finally the altitudinal trend demonstrated above is also discernable on the second axis.

Studies of this type are subject to errors of three kinds (Sneath and Sokal 1973: 376–380). First we must expect sampling error due to the natural variation at each locality. Second, errors of measurement may be introduced and may become highly significant when sample sizes are small. Finally, the study of a particular suite of localities may not accurately represent the overall pattern of geographic variation in the species. While considerable care has been taken to reduce errors of measurement, the samples available were lamentably small and may have included individuals of different ages. Inadequacies in geographic representation could also be quite significant in a species with a patchy distribution like *P. corroboree*. Only

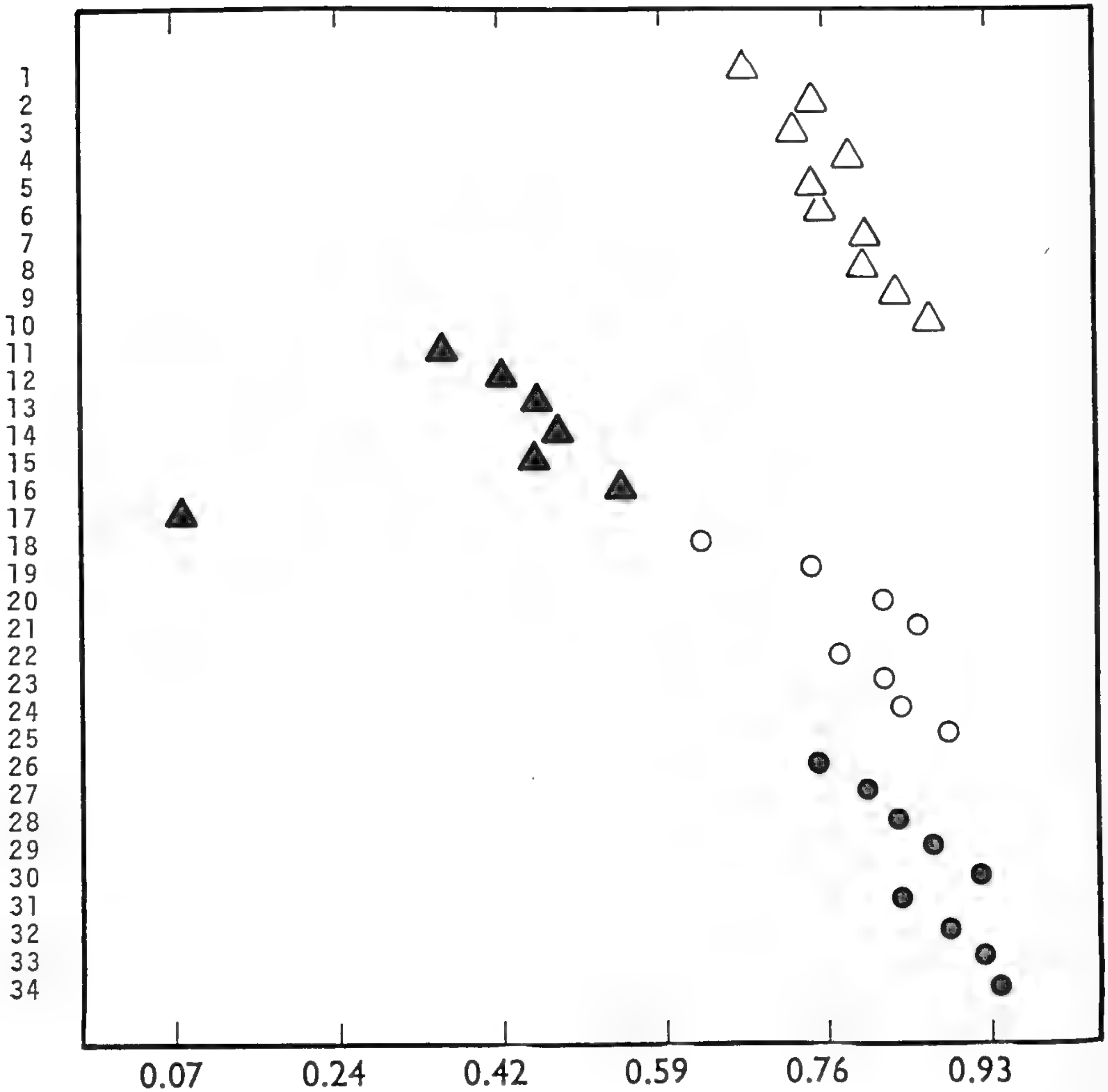

Figure 5. Variation of individual *P. corroboree* against the first varimax factor axis derived by Q-mode multiple factor analysis of the data presented in figure 3. Symbols are the same as those used in figure 4. Specimens 1–10 are from Smiggin Holes, specimens 11–17 are from Ginini Flat, specimens 18–25 are from Happy Jacks Plain; the remaining specimens are from Pretty Plain.

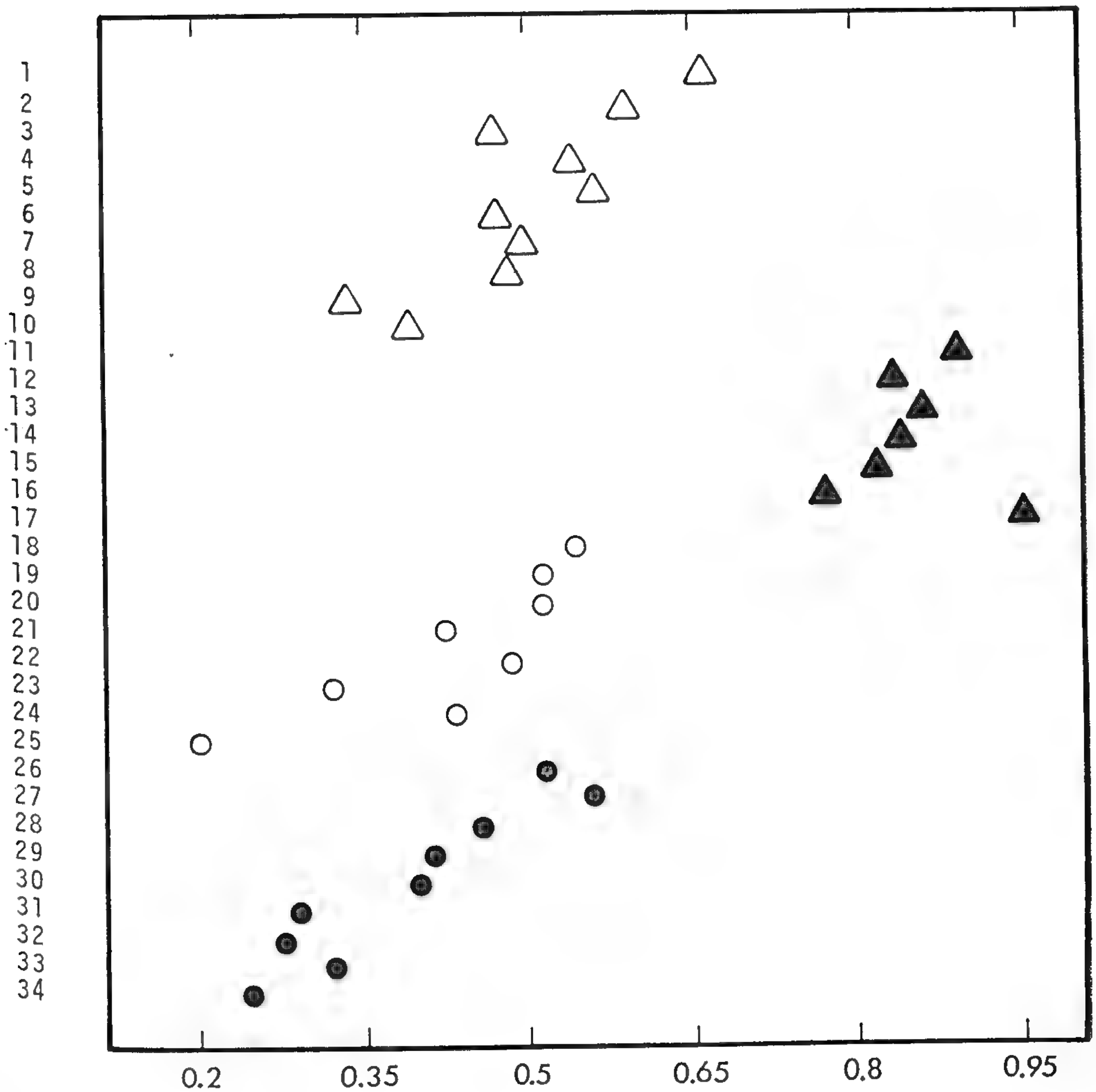

Figure 6. Variation of individual *P. corroboree* against the second varimax factor axis. Arrangement of the specimens is the same as in figure 5.

the study of larger samples from a larger number of sites will determine the significance of such errors in the present study. The preliminary results are certainly biologically meaningful and the situation warrants closer examination.

DISCUSSION

The loss of the terminal phalanx in the first toe of *P. corroboree* is surprising. The primitive phalangeal formulae of the anuran foot is apparently 2-2-3-4-3 (Lynch 1971, 1973). Phalangeal reduction has been reported in only four of the 16 families of modern anurans (rhinophrynids, certain bufonids and microhylids, and one leptodactylid: *P. guentheri* from Western Australia) (Parker 1940, Lynch 1973). A consideration of variation within the genus *Pseudophryne* as a whole (Woodruff 1972) supports the hypothesis that toe phalanx loss occurred independently in these two species.

Since I completed this study, Pengilley (1973) has published additional data on variation in "snout-urostyle" length in *P. corroboree*. Unfortunately our results are difficult to compare as different localities were sampled. Furthermore, Pengilley makes no allowance for the effects of growth on the single variable he measured. His results are consistent, however, with my finding of altitudinally dependent variation, and show that it occurs in the Brindabella Range as well as the Snowy Mountains.

The adaptive significance of the intraspecific variation in size and shape is not immediately clear. The altitudinal clines in body size and hind limb length may be tied to ecogeographic temperature factors. Alternatively, geographic differences in body size may be related to the sizes of competitors or prey species as suggested by Cody (1969) and Schoener (1969). With respect to this latter possibility the interaction between *P. corroboree* and *P. dendyi* in the northern Brindabella Range is particularly interesting. Pengilley (1971a) observed *P. dendyi* males moving into *P. corroboree* breeding sites at Coree Flat after the peak of the *P. corroboree* breeding season. He noted that when a male *P. dendyi* entered a burrow occupied by a male *P. corroboree* "...aggressive behaviour is always displayed by the male *P. corroboree* and often this can last for 3 or 4 hours before the male *P. dendyi* moves out of the burrow" (Pengilley 1971a: 87–88). There is no evidence that the two species hybridize and Pengilley suggests that differences in breeding season serve as the prime premating isolating mechanisms. Yet, it is known now that *P. dendyi* begins breeding activity as early as January at comparable altitudes in the Mt Cobberas area. Similarly, Pengilley (1973) noted males of *P. dendyi* commencing breeding activity at two localities south of Smiggin Holes (where no *P. corroboree* were present) as early as the end of January. These observations suggest that in the areas of sympatry *P. corroboree* may be physically delaying the breeding of *P. dendyi*. If this is the case then the relative size of the two species in the northern Brindabellas bears scrutiny. I was able to measure a sample of eight male *P. dendyi* from the Brindabella Range in the Australian Museum collection and the two species are compared morphometrically in table 2.

P. corroboree is smaller than *P. dendyi* with respect to nine of the ten variables measured, but *P. corroboree* has a longer body than *P. dendyi*. I suggest that direct interspecific competition in this area of sympatry may account for the selection of large body size in *P. corroboree*. This hypothesis would explain why the Brindabella Range sample is so different from the Snowy Mountains area populations and why this difference is restricted primarily to only one component of size and shape. This hypothesis can be tested by examining variation on a microgeographic level. Pengilley's (1973) data for several populations of the two species are unfortunately inadequate for this purpose.

TABLE 2. Comparison of two samples from the Brindabella Range. In each couplet the *P. corroboree* males (N = 7) precede the *P. dendyi* males (N = 8). Data are in mm.

Character	Mean	Range	Standard Deviation
Body length	26·93	(25·5–28·0)	0·89
	24·24	(22·0–26·7)	1·44
Tibia length	6·14	(6·0– 6·5)	0·24
	7·28	(7·0– 7·8)	0·31
Head width	6·31	(6·0– 7·0)	0·38
	7·26	(7·0– 7·6)	0·23
Head length	4·86	(4·5– 5·0)	0·24
	5·64	(5·3– 6·1)	0·27
Foot length	6·39	(5·6– 7·0)	0·49
	7·29	(6·9– 8·0)	0·36
Toe 1 length	0·71	(0·6– 0·8)	0·07
	1·28	(1·1– 1·4)	0·14
Toe 2 length	1·53	(1·4– 1·7)	0·11
	1·84	(1·6– 2·0)	0·16
Toe 3 length	2·61	(2·3– 2·8)	0·20
	2·95	(2·7– 3·2)	0·17
Toe 4 length	4·40	(3·8– 5·0)	0·41
	4·94	(4·5– 5·6)	0·35
Toe 5 length	1·71	(1·5– 1·9)	0·16
	1·76	(1·5– 2·2)	0·21

The observation of competition for breeding sites between *P. corroboree* and *P. dendyi*, and the possible effect of such competition on the size of *P. corroboree*, raise the question of the extent and significance of such interaction in the past. The fragmented distribution pattern of *P. corroboree* today suggests that this species has been more widely distributed. Whether range fragmentation is a result of climatic change or of interspecific competition cannot be established. The occurrence of *P. dendyi* on Mt Cobberas, in the Bago Range (northwest of Round Mountain), and near Kiandra (5·6 km SW. of Kiandra at 1,460 m), suggests that this species may have replaced *P. corroboree* in some areas. On the other hand, dramatic climatic changes have characterized *P. corroboree's* habitat during the late Cenozoic and undoubtedly have had a significant effect on its distribution. Many of this species breeding sites are less than 9000 years old. The Ginini Flat bog, one of the largest sphagnum peat bogs in southeastern Australia, is only about 3000 years old (Costin 1972).

The possibility of intense interspecific competition in the northern Brindabella Range raises another difficult question. In connection with Pengilley's (1971a) detailed analysis of the behaviour of the Coree Flats population it remains uncertain whether the behaviour of *P. corroboree* in this area is markedly affected by the presence of *P. dendyi*. Behavioural convergence and divergence are likely to evolve in this situation (Cody 1969; Grant 1972) and we should not regard the Coree Flats population as typical of the species until the possible effects of these phenomena have been examined.

Finally, the geographic variation in coloration of *P. corroboree* deserves attention. Marked differences in the amount of black and yellow pigmentation have been noted between the Brindabella Range and Snowy Mountains area samples. The overall pattern is probably not aposematic. It is clearly disruptive, blending closely with the sphagnum moss of the animal's normal habitat. Although biochemical analyses have not been undertaken my observations of developing *Pseudophryne* embryos (Woodruff 1972) suggest that three cell types are responsible for

this pattern: melanophores (containing melanin), xanthophores (containing yellow carotenoids), and guanophores (containing white platelets of guanine or related purines), In terms of chromatophores we must explain why there has been selection for more melanophores in the Brindabella Range populations and more xanthophores in the Snowy Mountains area. While I could speculate about the relative role of these changes in thermoregulation, fat storage, protection from predators or parasites, and competitive interactions with *P. dendyi*, such a discussion would be premature.

ACKOWLEDGMENTS

H. G. Cogger (Australian Museum), J. Dixon (National Museum of Victoria), and M. J. Littlejohn (University of Melbourne) permitted me to examine specimens in their care. R. S. Frankenberg and J. Sepkoski assisted me with the X-radiography and computer programming respectively. I am indebted to S. J. Gould for the CABFAC programme, advice on the interpretation of the multivariate analysis, and for his critical reading of the manuscript.* While working on this problem I received support from a Commonwealth of Australia Postgraduate Award and a Research Fellowship at the Museum of Comparative Zoology, Harvard University.

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DEMANIA MACNEILLI, A NEW SPECIES OF XANTHID CRAB FROM NORTHERN QUEENSLAND (CRUSTACEA: DECAPODA)[1].

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SUMMARY

The first occurrence of the genus *Demania* in Australian waters is reported with the description and illustration of *D. macneilli*, new species, from off northeastern and central eastern Queensland in from 17 to 20 fathoms. The new species is compared with other members of the genus, which inhabits the Indian and western Pacific oceans and is known to contain species poisonous to man.

INTRODUCTION

While on sabbatical leave from the University of Southern California during the early part of 1973, the writer spent a fortnight, March 15-29, at the Australian Museum, Sydney, reviewing the crabs of the family Xanthidae preparatory to undertaking field studies along the Queensland coast. He was greatly assisted in this familiarization process by an unpublished list of Australian Decapoda prepared by F. A. McNeill, J. C. Yaldwyn and D. J. G. Griffin, late past, recent past, and present curators of Crustacea, respectively, that enabled him to tell at a glance which of the Australian species were known to occur in Queensland waters, as distinct from those of New South Wales on the one hand and the Northern Territory on the other. Having recently described a poisonous species of the genus *Demania* Laurie (1906) from the Philippines, *D. toxica* Garth (1971), the writer was particularly interested to find listed from Queensland a *Demania* sp. which on preliminary inspection appeared unlike any with which he was familiar. That he should be entrusted with the study of these crabs, and with their ultimate description, did not occur to him at the time; however, when after his return to the United States in August, 1973, at the suggestion of J. C. Yaldwyn, now at the National Museum of New Zealand, Wellington, he was asked by Diane E. Brown, assistant in the Department of Marine Invertebrates, to have a further look at them, he accepted with alacrity. They proved, as Miss Brown had surmised, not to fit the characteristics of *D. toxica* or of other known species of the genus, and are accordingly described as new. Types are deposited in the Australian Museum (AM), Sydney, N.S.W.

[1]Allan Hancock Foundation Contribution No. 355

Records of The Australian Museum, 1976, **30**, 113–117, Figure 1.

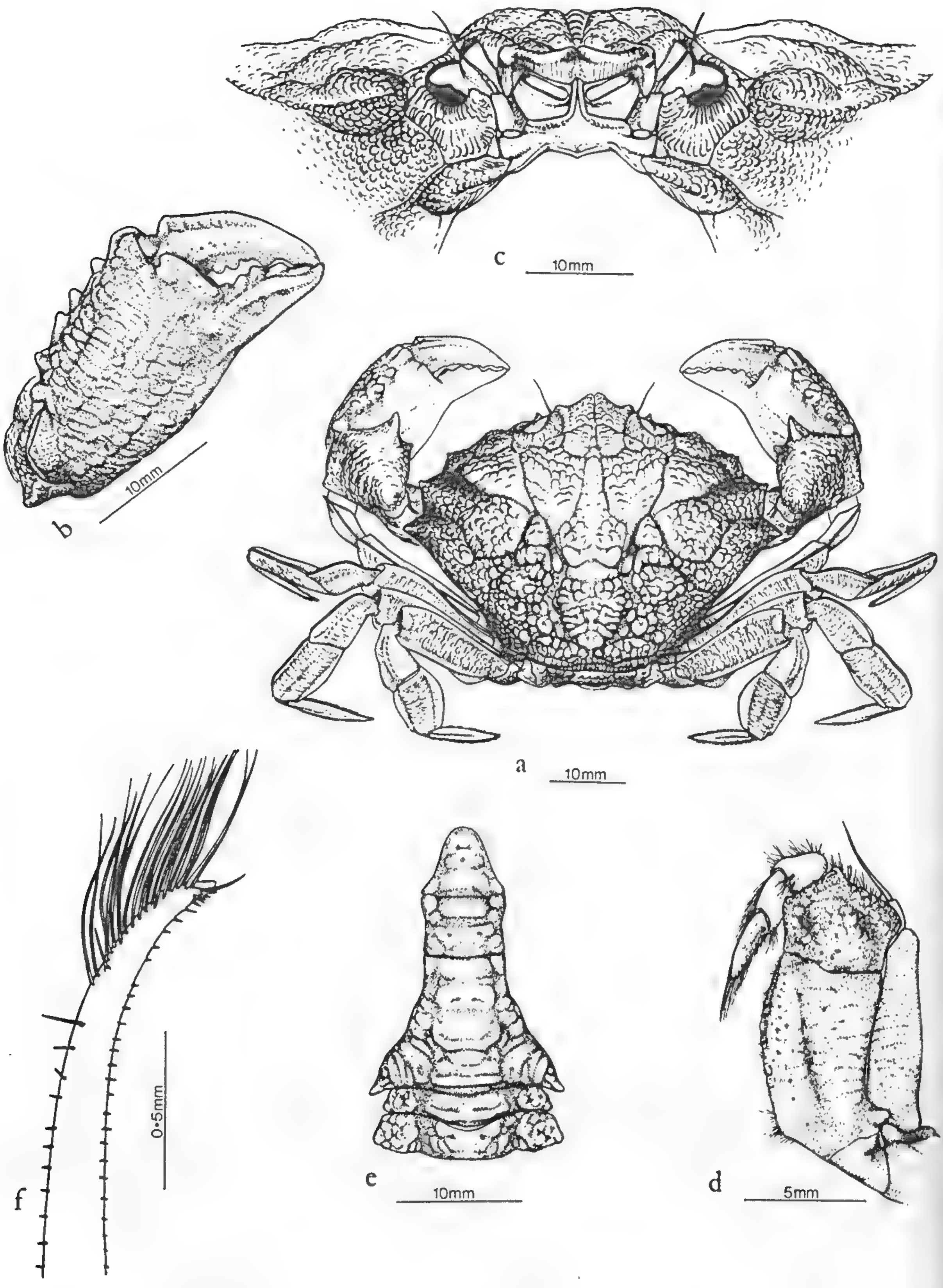

Fig. 1.—*Demania macneilli,* new species. Male holotype: a, dorsal view; b, right chela; c, frontal view; d, left outer maxilliped; e, abdomen; f, first pleopod.

SYSTEMATIC ACCOUNT

Demania macneilli new species
Fig. 1, a-f

TYPES: Male holotype, AM P. 20629, and one male and two female paratypes, AM P. 14786, from Townsville-Cairns area, northeast Queensland, Australia; November, 1964; trawled in 20 fathoms; T. Nielson, collector. Female paratype, AM P. 14785, from off Cape Bowling Green, near Townsville, northeast Queensland; late October, 1964; trawled in 17-18 fathoms; T. Nielson, collector. Female paratype, AM P. 14780, from off Gladstone, central eastern Queensland; mid-1963; trawled; Miss J. Booth, collector.

MEASUREMENTS: Male holotype, length of carapace 39.1 mm, width of carapace 50.3 mm, of front 12.2 mm, of fronto-orbit 22.8 mm, length of right chela 31.7 mm, of dactyl 15.6 mm, height of palm 15.2 mm. Male paratype, length 19.1 mm, width 24.3 mm. Female paratype, length 45.4 mm, width 58.4 mm.

DIAGNOSIS: Front produced, median notch narrow, frontal lobes concave. Carapace with squamous tubercles becoming smoother anteriorly and medially. Anterolateral margins triangularly dentate. Walking legs faintly sculptured, cristate above and below. Male first pleopod with a row of 20 longer setae on convex margin.

DESCRIPTION: Carapace pentagonal, front produced, biconcave, anterolateral margins arcuate, strongly dentate, posterolateral margins concave. Surface convex anteroposteriorly, slightly so from side to side. Regions well separated by clearly incised, pilous grooves, areoles covered with squamiform tubercles tending toward obsolescence on proto- and mesogastric, hepatic and epibranchial regions (2M, 3M, 2L, 5L of Dana, 1852:29), particularly in older specimens. Posterior two-fifths of carapace with larger tubercles becoming more numerous and densely packed laterally and anteriorly, where they extend onto the anterolateral teeth. Front strongly produced medially, divided by a narrow (button-hole) slit into two concave, receding lobes, each with an outer lobule. Orbital border smooth, inner margin swollen, two superior notches on outer margin and one inferior notch; a blunt tooth at inner angle. Anterolateral margin arcuate, edge thin, divided into four lobes exclusive of the small exorbital lobe, third and fourth lobes largest, triangularly dentate, tipped with a small tubercle, fourth tooth laterally directed, forming an obtuse angle with third tooth and a concavity with the posterolateral border.

External maxilliped smooth and punctate proximally, ischium longitudinally grooved, merus irregularly pentagonal, broadening distally, tuberculate anteriorly, a depression in line with ischial groove.

Pterygostomian region densely and finely granulate; sternum with coalesced tubercles forming a vermiculated pattern.

Chelipeds equal, upper, outer, and lower surfaces of merus, carpus, and manus tuberculate. Merus with crest on superior margin terminating in two well separated, lamellate lobes. Carpus broadening distally, faintly grooved anteriorly and medially, tubercles inward of medial groove obsolescent, a prominent inner spine and a tubercle beneath. Manus with five larger superior tubercles, of which one or two are double, tubercles of outer surface superimposed on a reticulating pattern of vertical and horizontal ridges and arranged in longitudinal rows of which two extend onto pollex. Dactylus compressed, ridged, and grooved, superior ridge entire, meeting pollex with a slight gape, pollex slightly deflexed, bearing five teeth, the last tooth terminal.

Walking legs compressed, merus, carpus, and propodus faintly sculptured, cristate above, merus and propodus crested beneath, merus doubly so, propodus of last leg broadened, foliaceous; dactyl long, straight or slightly incurving, margins setose.

Male abdomen with segment 3 slightly broader than segment 1, segments 3-5 fused, segments 2-6 with two transverse bars medially and two or more rounded tubercles externally, segment 6 rectangular, longer than broad, segment 7 narrowly triangular, length and breadth equal, sides concave, tip rounded.

Male first pleopod slender, cylindrical, gradually tapering, and curving toward tip; convex margin with a row of short setae proximally and a row of about 20 longer, plumose setae distally; concave margin with a row of short setae proximally and a cluster of short setae terminally, with one longer seta extending beyond recurved and hollowed-out tip.

REMARKS: The new species from northern Queensland compares best with *Demania scaberrima* (Walker, 1887) from Singapore, from which it differs in having the carapace less scabrous, especially on 2M, 3M, 2L, and 5L, the front more advanced medially, the anterolateral teeth more prominent, especially the last, imparting a concavity to the posterolateral border, the chelipeds less scabrous, the superior margin of the dactylus non-granulate, with only one outer carina, the walking legs all alike (the merus of the last not spinulous), smoothly rimmed above and below (not serrate), the meri of the walking legs lacking a subterminal notch, the abdomen of the male with the rows of rounded tubercles fused into transverse bars. It differs from *D. cultripes* (Alcock, 1898) (not Sakai, 1939) in having the tubercles near the inner angle of the wrist and near the base of the thumb (pollex) not noticeably more "worn" than elsewhere and the raised rows of granules on the dorsal surfaces of the leg-joints obsolete, rather than obsolescent. It resembles *D. cultripes* in having the tubercles of the mesogastrium still more "worn" than in *D. baccalipes* (Alcock, 1898), and in having a stout spine at the inner angle of the carpus of the cheliped (this character obtained from the Serène key, in manuscript). Closer comparison with *D. cultripes* from Singapore and *D. baccalipes* from Ceylon is not possible, as their brief descriptions depend on the more complete description of *D. scaberrima* given by Alcock (1898), they have never been illustrated, and specimens said by Serène (personal communication) to be found in the National Museum, Singapore, were not available to the writer when he visited Singapore in July, 1973.

I take pleasure in naming this handsome crab in honour of the late Frank A. McNeill, whose report on the decapod and stomatopod Crustacea of the Great Barrier Reef Expedition (McNeill, 1968) first directed my attention to the carcinological richness of the Queensland coast.

NOTE OF CAUTION

The writer would be remiss, in describing the first species of *Demania* to have been reported from Australian waters, not to caution collectors, fishermen, SCUBA divers, and reef walkers who might encounter this crab, of the poisonous nature of some of its relatives. *D. toxica* Garth, as its name implies, is highly toxic and its ingestion has caused the death of at least one person in the Philippines (Alcala and Halstead, 1970). The toxicity of *D. reynaudii* Milne Edwards in the Gulf of Tonkin is also well known (André, 1931; Holthuis, 1968). Like poisonous reef fishes, poisonous crabs are usually brightly coloured; unfortunately, the colour of *D. macneilli* was not recorded in life; the four specimens have lost all traces of colour after ten years in spirit.

ACKNOWLEDGEMENT

The author is indebted to J. C. Yaldwyn, National Museum of New Zealand, Wellington, D. J. G. Griffin and Diane E. Brown, Australian Museum, Sydney, for facilitating this study, and to R. Serène, former UNESCO marine science regional expert for Southeast Asia, Singapore, for a second use of his manuscript key to *Demania*. Illustration by Jerry J. Battagliotti, fine arts diplomate, was supported by Bio-medical Sciences Support Grant RR07012-08 from the Division of Research Resources, Bureau of Health Professions Education and Manpower Training, National Institutes of Health, USA.

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(ii) The author's name and professional address.

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(iv) A list of contents may be included if the paper is very long.

(v) Introduction.

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A NEW TERRESTRIAL AMPHIPOD FROM LORD HOWE ISLAND

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SUMMARY

Parorchestia gowerensis (Amphipoda: Talitridae) is newly described from the summit of Mt. Gower, Lord Howe Islands, Australia, and supports Stebbing's original concept of the genus *Parorchestia*.

INTRODUCTION

In the course of studies on the terrestrial amphipod fauna of the Australian region, a small collection from the Lord Howe Islands was kindly made available by Dr. J. W. Evans and Miss Elizabeth Pope, of the Australian Museum, Sydney. The material contained a distinctive species, previously undescribed, that is tentatively assigned to the genus *Parorchestia* Stebbing. Although nearly all known species of this group are members of the cryptozoic "leaf-litter" fauna and primarily terrestrial, some occur in association with the nests of marine birds, and in other habitats in close proximity to the sea shore. Smithers *et al* (1974) have commented on the value of small cryptozoic invertebrates in answering scientific questions, especially pertaining to the origin and evolution of isolated biotas. To be of value in this respect, however, much more careful collecting and study of these remarkable crustaceans in their native habitat is needed.

SYSTEMATICS

Genus *Parorchestia* Stebbing 1899; emend Bousfield 1964

Stebbing's original definition of the genus was based on characteristics of the New Zealand leaf-mould species *P. tenuis* (Dana) and *P. sylvicola* (Dana). Several, more recent workers such as Shoemaker (1942), Hurley (1957), Bulycheva (1957), and Barnard (1969) have expanded the definition of *Orchestia* to include the distinctive features used by Stebbing in demarcating *Parorchestia*. However, cognizant of the pressing need for taxonomic refinement of the now unwieldy and unrealistic generic concept of *Orchestia*, containing well over 100 species, the writer (1961, 1964, 1971) has outlined further systematic bases upon which Stebbing's original generic distinction may be upheld. Further revisionary work will be required as new material from the vast complex of Indo Pacific islands comes to hand, and significance of coxal gill and brood plate structure at higher taxonomic levels is ascertained. In the writer's view, the *Parorchestia* complex of leaf-litter hoppers is basically distinct from the true littoral marine facies represented by the generic

Records of The Australian Museum, 1976, **30**, 118–122, Figures 1–2.

type, *Orchestia gammarellus* (Pallas). The continued recognition of *Parorchestia*, would, in the interim, follow Stebbing's original broad definition of the genus that includes both *P. tenuis* and *P. sylvicola* groups of species.

Parorchestia gowerensis n. sp.
figs. 1, 2.

TYPES: Holotype ♀ (ovig.), ♂ allotype, P. 14507, Mt. Gower, Lord Howe Island coll. D. Linklater, among damp moss, February 1957. Three ♀♀ paratypes, P. 14506, same data as for P. 14507. Three topotypes, 2 ♀♀, (P. 10859), 1 ♂ (P. 10860), old collections, Mt. Gower, among damp moss, 2485 ft. a.s.l. (ident. as *O. pickeringi* by K. Sheard); all in the Australian Museum. Holotype slide mount in the National Museum of Natural Sciences, Ottawa.

DESCRIPTION: Female (13 mm). Head and buccal mass deeper than long; eye subrotund, medium-large, black. Antenna 1 slightly exceeding peduncle 4 of antenna 2, flagellum 5-6 segmented. Antenna 2 slender, peduncle 5 distinctly longer than 4, flagellum of 23 segments, longer than peduncle, segments with whorls of short stiff setae.

Upper lip moderately deep, narrow; apex rounded, pilose. Lower lip deep, inner shoulders pilose. Mandible, right incisor 5-dentate, left incisor 6-dentate; right lacinia apically 4-cuspate, with five small proximal tubercles, left lacinia 4-cuspate. Maxilla 1, palp minutely 2-segmented, set about mid-way along outer margin; outer plate, apical spine-teeth all strongly pectinate. Maxilla 2, outer plate larger, outer margin distally with short stiff setae. Maxilliped, inner plate broadening distally, inner margin and face with 6-8 stout plumose setae; apex with 3 short blunt spine-teeth, inner smallest; outer plate short, apex broadly rounding, with strong submarginal setal row; palp short, very broad, terminal (4th) segment short but distinct, conical.

Gnathopod 1, coxal plate much shorter than 2, rounded below, lightly spinose; inner shelf weakly spinose; segment 5 distinctly longer than 6, lower margin distally expanded or "tumid"; segment 6 slightly widening distally; dactyl short, tip not exceeding vertical palm. Gnathopod 2, coxal plate deep, posterior marginal process short; segment 2 sublinear, slightly broadened anteriorly; segment 3 slightly longer than 4, the latter with posterior marginal blister; segment 5 longer than 6, posterior margin distally broadest; dactyl closely subterminal.

Peraeopods 1 and 2, coxal plates subquadrate, posterior processes short; segment 5 relatively long, nearly equal to 4; dactyls short, simple. Peraeopod 3, coxal plate large and deep, posterior lobe relatively large; segment 2 subovate, posterior margin spinose. Peraeopods 4 and 5 slender, much longer than 3, 5 slightly longer than 4; coxa of peraeopod 4 with large deep posterior lobe; coxa of peraeopod 5 shallowly rounding below; segment 2 nearly as broad as deep, convex posterior margin weakly serrate; dactyls slender, short.

Coxal gills relatively short, sac-like, those of gnathopod 2 and peraeopod 4 not convoluted nor multi-lobate. Brood plates relatively large and broad, distal margins with 9-14 simple setae.

Abdominal side plates 1-3 smooth below, hind corners slightly acute, posterior margins with 1-2 minute setae. Pleopods 1 and 2 slender, subequal, inner ramus with 9-11 segments, much longer than 7-segmented outer ramus; peduncle distally with 4-5 marginal plumose setae; pleopod 3 similar in type but much the shortest, rami with 8 and 5 segments respectively; 2 coupling spines on all peduncles.

Uropod 1, rami subequal, margins laterally spinose; margins of peduncle moderately spinose; inter-ramal spine simple, medium-strong. Uropod 2, rami shorter, stouter, subequal, marginally spinose. Uropod 3, peduncle stout, with sub-apical posterior group of one long and three short spines; ramus shorter, slightly tapering, with three apical spines. Telson broadly spade-shaped, apex slightly cleft, lobes each with apical cluster of short spines, and a larger, dorsal spine proximally.

DESCRIPTION: Male (9.0, 12.5 mm). Antenna 2 slender, geniculate at flagellum, as in ♀. Gnathopod 1, segment 4 with posterior "blister" or tumescence; segment 6 much shorter than 5, tumescent postero-distally; dactyl short, not reaching lower margin of truncate palm. Gnathopod 2, segment 2 slightly expanded posteriorly, margin with a few stout spines; segment 3 with rounded, winglike anterior flange; segment 6 large, subovate, palm oblique, convex, spinose, posterior angle with groove to accommodate tip of slender, curved dactyl; in older males, dactyl may be grossly curved, apparently non-functional in amplexus.

REMARKS: This species is closely related to the group of *Parorchestia marquesana* Shoemaker 1942 and *P. klawei* Bousfield, 1961, in general features of gnathopods, mouthparts, pleopods and uropods, the latter with outer ramus marginally spinose. In *P. gowerensis,* however, the peduncles of the pleopods are distinctive from these in having dual coupling spines and outer marginal plumose setae; and the peraeopods are much more slender and elongate, lacking sexual dimorphism. Although this new species is apparently endemic to the Lord Howe Islands, the probability is high that other species of terrestrial amphipods await discovery in this small but ancient subtropical archipelago.

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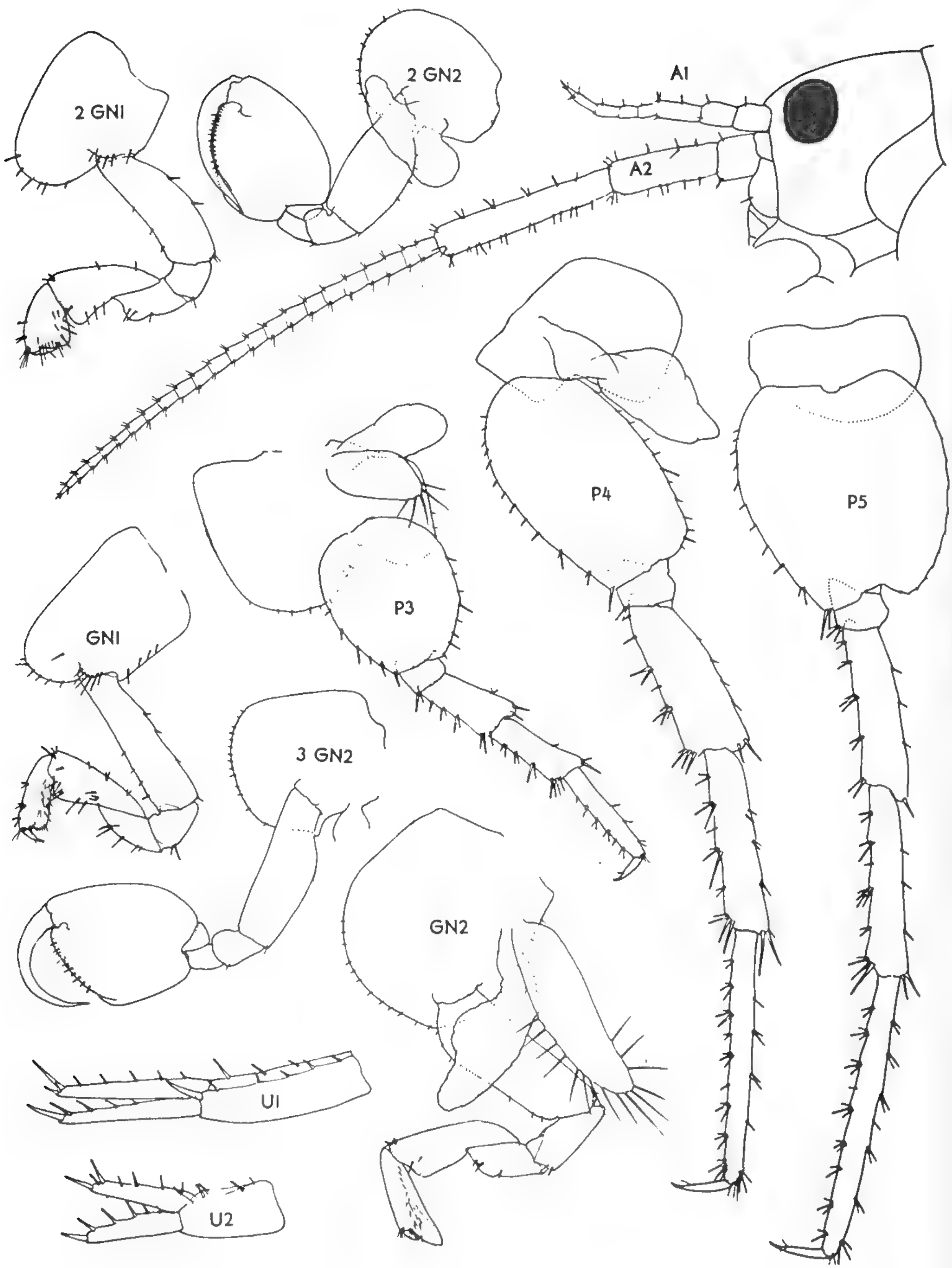

Fig. 1.—*Parorchestia gowerensis* n. sp. Lord Howe Island. 1. Holotype female, 13 mm; 2, 3, topotype males, 9 mm and 12.5 mm. *Abbreviations* A, antenna; GN, gnathopod; P, peraeopod; U, uropod.

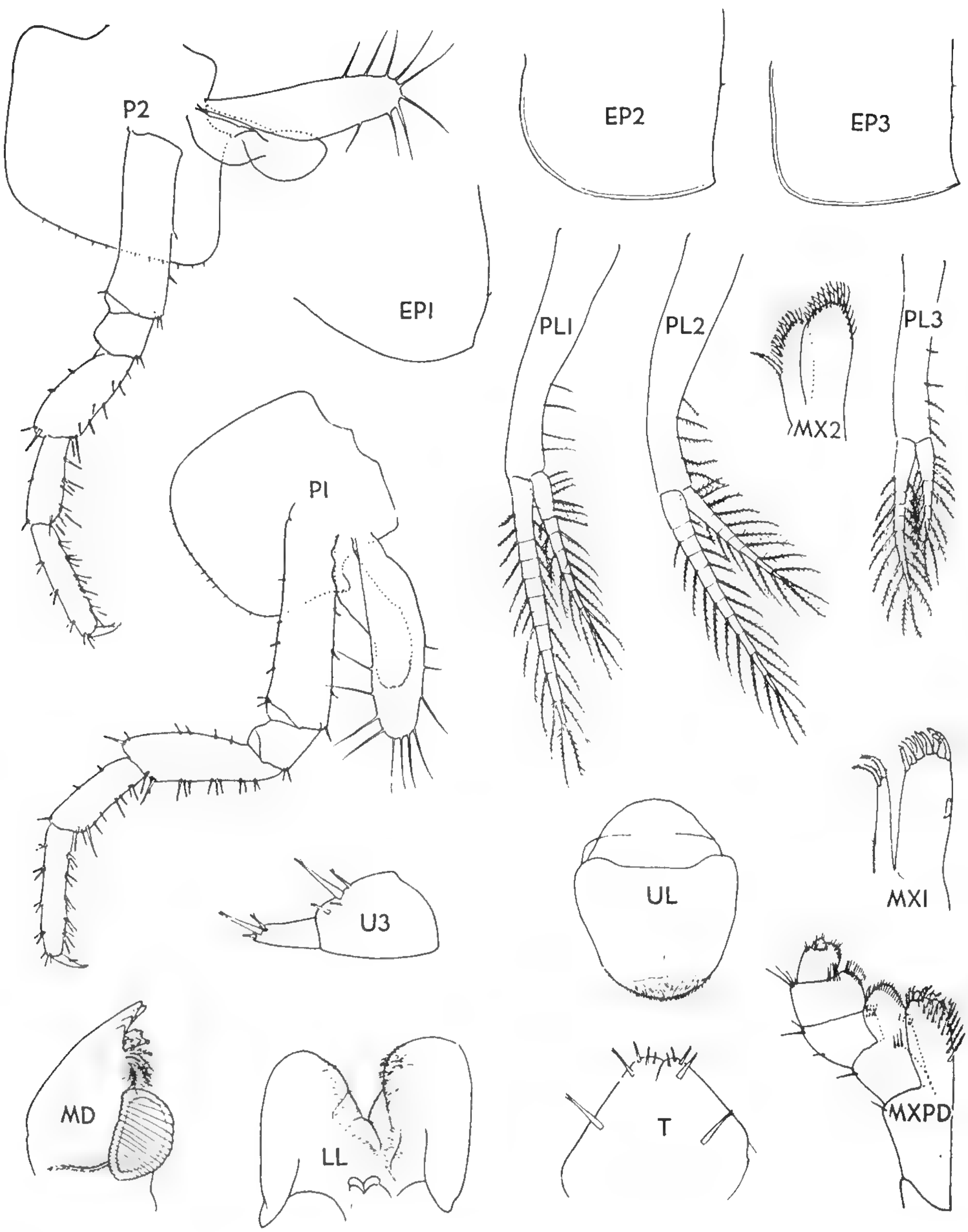

Fig. 2.—*Parorchestia gowerensis* n. sp. Lord Howe Island. 1. Holotype female, 13 mm; 2, topotype male, 9 mm. *Abbreviations* EP, abdominal side plates; LL, lower lip; MD, mandible; MXPD, maxilliped; MX, maxilla; P, peraeopod; PL, pleopod; T, telson; UL, upper lip; U, uropod.

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A NEW SPECIES OF *BOCCARDIA* (POLYCHAETA: SPIONIDAE) FROM TWO FRESHWATER LAKES IN SOUTHEASTERN AUSTRALIA

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SUMMARY

Boccardia limnicola, is described and illustrated. The species, closely related to marine forms, is distinguished by an unusual branchial arrangement. Ecological notes are provided.

INTRODUCTION

Some spionid polychaetes were collected from two freshwater lakes in southeastern Australia by Brian V. Timms in the spring of 1970. The two lakes are Lake Bong Bong near Glenelg River estuary, Victoria and Lake Barracoota near Mallacoota estuary, Victoria. Polychaetes from the two lakes have been determined to be of the same species. These specialized spionids represent a species new to science and are described in the present study as *Boccardia limnicola*. Types are selected from the Lake Bong Bong collections and are deposited in the Australian Museum, Sydney (AM). The Lake Barracoota material remains with the authors.

SYSTEMATIC ACCOUNT

Boccardia limnicola, new species

MATERIAL EXAMINED: Lake Bong Bong, Victoria, November 17, 1970, in sand, 0.5 m depth HOLOTYPE AM W. 7033; 19 PARATYPES AM W. 7034. Lake Barracoota, October, 1970, in coarse sand covered by detritus, 1.0-3.0 m. depth (3).

Records of The Australian Museum, 1976, **30**, 123–128, Figures 1–13.

DESCRIPTION: Largest specimens with 70 setigerous segments, length 13.0 mm, width at setiger 5 1.5 mm.

Prostomium incised on anterior margin, extending posteriorly as a caruncle to middle of setiger 2 (fig. 1). Caruncle with low elevation or hump at about anterior margin of setiger 2. Nuchal tentacle absent. Four eyes, anterior pair cup-shaped, located further apart than posterior oval pair. Palps long, extending posteriorly to setiger 10 or 12, sometimes lightly pigmented along margin of ciliated groove.

Prostomium, peristomium and first five setigers roughly subtriangular in outline. Setiger 1 with well-developed fascicles of capillary noto- and neurosetae. Setae of notopodium longer but lobe of the neuropodium better developed. Both noto- and neuropodia shifted towards the dorso-median line. In setiger 2 they show a similar but less exaggerated shift. Parapodia of setigers 2, 3, 4, –, 6 and succeeding setigers contain fascicles of long capillary noto- and neurosetae with narrow wings along one margin. In posterior setigers, notosetae fewer in number, longer and lacking the narrow wing. Specialized posterior notosetae absent. Bidentate neuropodial hooded hooks begin on setiger 7 (fig. 2). Hooded hooks without constriction on shaft and with only a slight angle between the two teeth. There are up to six hooks per neuropodium accompanied in anterior setigers by fine capillary setae (fig. 3). The neuropodial capillary setae continue in posterior setigers but the number of hooded hooks is reduced to three.

Setiger 5 noticeably modified, about twice as large as preceding and succeeding setigers. Notosetae including closely bundled superior dorsal fascicle of short pointed setae (fig. 10) and curved row of heavy spines alternating with companion setae. Heavy spines simple and falcate with no accessory structures (figs. 6-9). Unworn companion setae tapering distally with sharp tip (fig. 5); blunt when worn (fig. 4). Neurosetae represented by small fascicle of capillary setae (fig. 11).

Branchiae present on setigers 2, 3, 4, 5, 6, 7 and continuing posteriorly for about one-half of body, smallest on setigers 2 and 5, long and finger-like in appearance on other setigers and reaching nearly to the mid-line (fig. 1).

Well-developed groove on ventral surface of posterior portion of body (fig. 12). Pygidium with four thickened irregular lobes (fig. 13).

COLOUR: The worms are light tan in colour (in alcohol) with some dusky-brown pigment dorsally on the peristomium, the anterior border of the first few setigers, and the caruncle.

REMARKS: The genus *Boccardia* has been recently reviewed by Blake and Woodwick (1971). The known species, all marine, were placed in two distinct groups. In one group the heavy spines of setiger 5 are all of one type, simple and falcate. These species also have a group of superior dorsal setae located dorsal to the heavy spines. The second group has two types of heavy spines in setiger 5 and no superior dorsal setae. *Boccardia limnicola* clearly belongs to the first group. It differs from its four closest relatives by several taxonomic characteristics (Table 1).

Boccardia limnicola is unique within the genus in having branchiae on setiger 5. The only other spionid species of the *Polydora-Boccardia* complex to have branchiae on setiger 5 is *Tripolydora spinosa* Woodwick (1964).

ECOLOGY: Lake Bong Bong has a maximum salinity of 0.36‰ and Lake Barracoota has a 0.30‰. Average lake and river salinities are about 0.15‰ and the ocean about 35.0‰ (Pearse and Gunter, 1957). The Australian lakes have maximum depths of 6.5 and 8.0 m, respectively. Both lakes are indirectly connected to estuaries. Lake Bong Bong is connected by a long (six mile) swamp to the Glenelg River estuary which opens to the sea not far from the Victoria-South Australia border. Lake Barracoota is now cut off from the ocean by sand dunes and swamps but apparently was once part of the Mallacoota estuary near the Victoria-New South Wales border.

Associated organisms in Lake Barracoota include two species of isopod, one athurid and one sphaeromid.

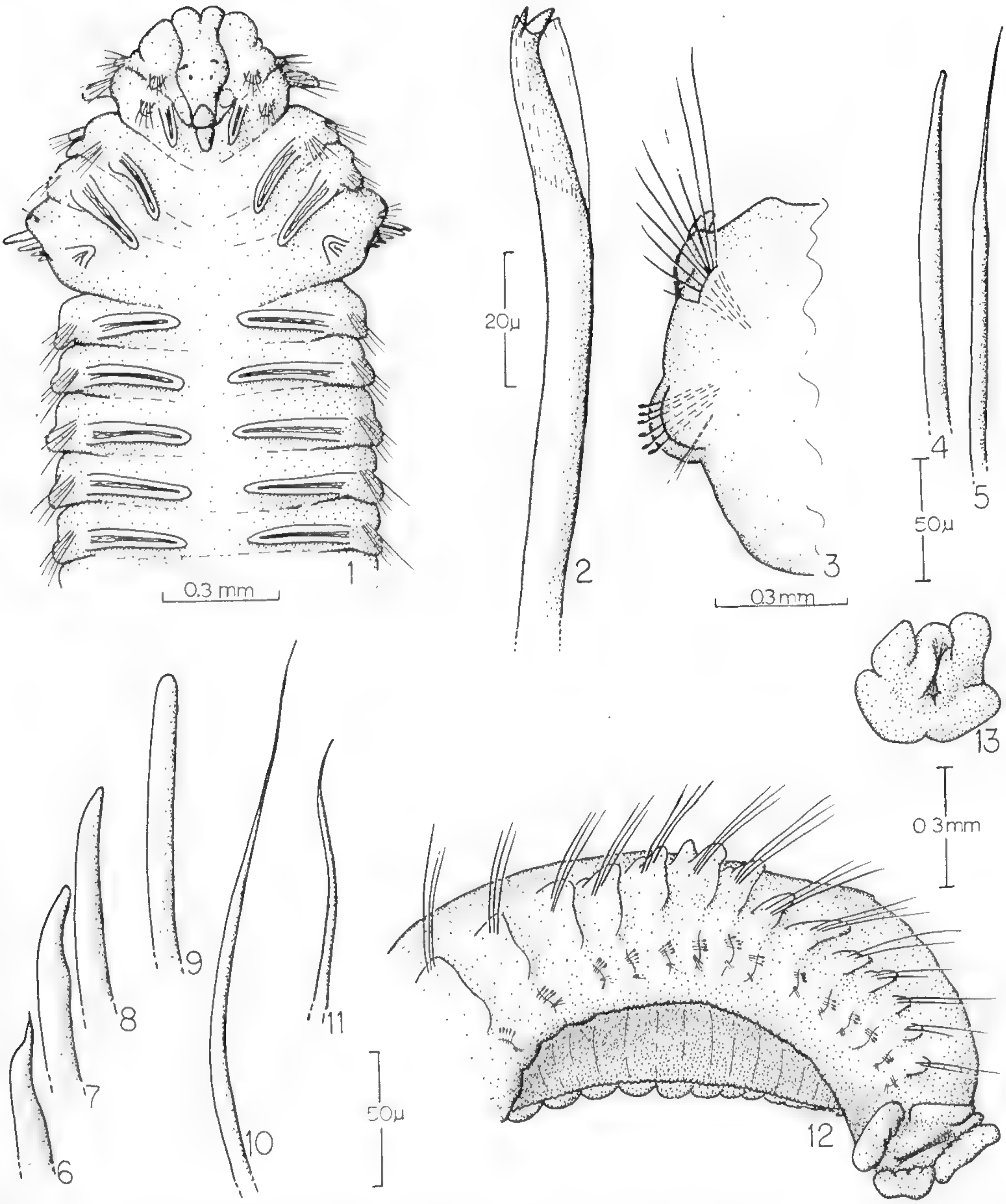
Although several spionids are known from estuaries or other brackish water habitats (Wesenberg-Lund, 1958), we know of no previous record of a freshwater spionid.

ACKNOWLEDGEMENTS

We are grateful to Brian V. Timms (Avondale College, New South Wales) for the opportunity to study the collections and for providing ecological information on the two lakes. Illustrations were prepared by Mrs. Floy McMillan Zittin.

Table 1. Some taxonomic characteristics of five related species of *Boccardia*.

Species of *Boccardia*	Anterior branchiae on setigers	Notosetae on setiger 1	Prostomial nuchal tentacle	Prostomial caruncle terminates on	Posterior notopodial spines	Reference
B. ligerica Ferroniere, 1898	2, 3, –, –, –, 7	absent	absent	end of Setiger 2	present (recurved)	Blake & Woodwick, 1971
B. sp. (*redeki* sensu Okuda, 1937)	2, 3, –, –, 6, 7	absent	present	end of Setiger 3	?	Okuda, 1937
B. hamata (Webster, 1879)	2, 3, –, –, 6, 7	absent	absent	end of Setiger 3	present (recurved)	Blake, 1966
B. truncata Hartman, 1936	2, 3, 4, –, 6, 7	absent	absent	end of Setiger 2	absent	Hartman, 1936
B. limnicola n. sp.	2, 3, 4, 5, 6, 7	present	absent	middle of Setiger 2	absent	this paper



Figs. 1-13.—*Boccardia limnicola:* 1, anterior end, dorsal view, palps omitted; 2, hooded hook; 3, parapodium from setiger 10, anterior view; 4, worn companion seta from setiger 5; 5, unworn companion seta from setiger 5; 6-9, heavy spines of setiger 5 showing series of wear from unworn (6) through worn (9); 10, notoseta from superior dorsal fascicle of setiger 5; 11, neuroseta from setiger 5; 12, posterior end, lateral view; 13, pygidium.

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A NEW SPECIES OF CARDINALFISH (APOGONIDAE) FROM NORTHERN QUEENSLAND & PAPUA NEW GUINEA

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SUMMARY

Apogon albimaculosus, a new species of cardinalfish, is described from eight specimens caught between Townsville in north Queensland and Yule Island in Papua New Guinea. The species is easily distinguished from other members of the family by its colouration. *A. albimaculosus* is provisionally placed in the subgenus *Nectamia*, but its precise relationships are obscure.

INTRODUCTION

In two samples of fish taken during experimental trawling near Yule Island, Papua, in November 1970 and February 1971, were single specimens of an apogonid fish which could not be assigned to any known species from the Indo-Australian region. A third specimen from near Daru, western Papua, was discovered in the fish collection at the Fisheries Research Station in Port Moresby. Enquiries revealed the presence of five more specimens in collections in Australia. The species represented by these eight specimens is placed in the subgenus *Nectamia* Jordan, in the genus *Apogon* Lacépède.

The description is based on the holotype and seven paratypes. Counts and proportions are given for the holotype, followed in parenthesis by the range and mean of those for the paratypes, except when these are the same as for the holotype. Measurements in millimetres for all types are presented in Table 1. These were made with dial calipers and recorded to the nearest 0.1 mm. Standard length is abbreviated as S.L. The last rays in the dorsal and anal fins are counted as one element each. One paratype (AM. I. 16232-001, 58 mm S.L.) was cleared and stained in Alizarin Red-S, using Taylor's (1967) enzyme method.

The holotype and three paratypes are deposited at the Australian Museum, Sydney (AM). Another paratype is lodged at the CSIRO, Division of Fisheries and Oceanography, Cronulla (CSIRO F. & O.). The three Papua New Guinea paratypes are held at the Australian Museum "in trust" to be eventually returned to Port Moresby upon the establishment of a curated fish collection at the Papua New Guinea National Museum.

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[1] Present address: 8 Edwards Street, Forster, NSW, Australia

Records of The Australian Museum, 1976, **30**, 129–136, Figures 1–2.

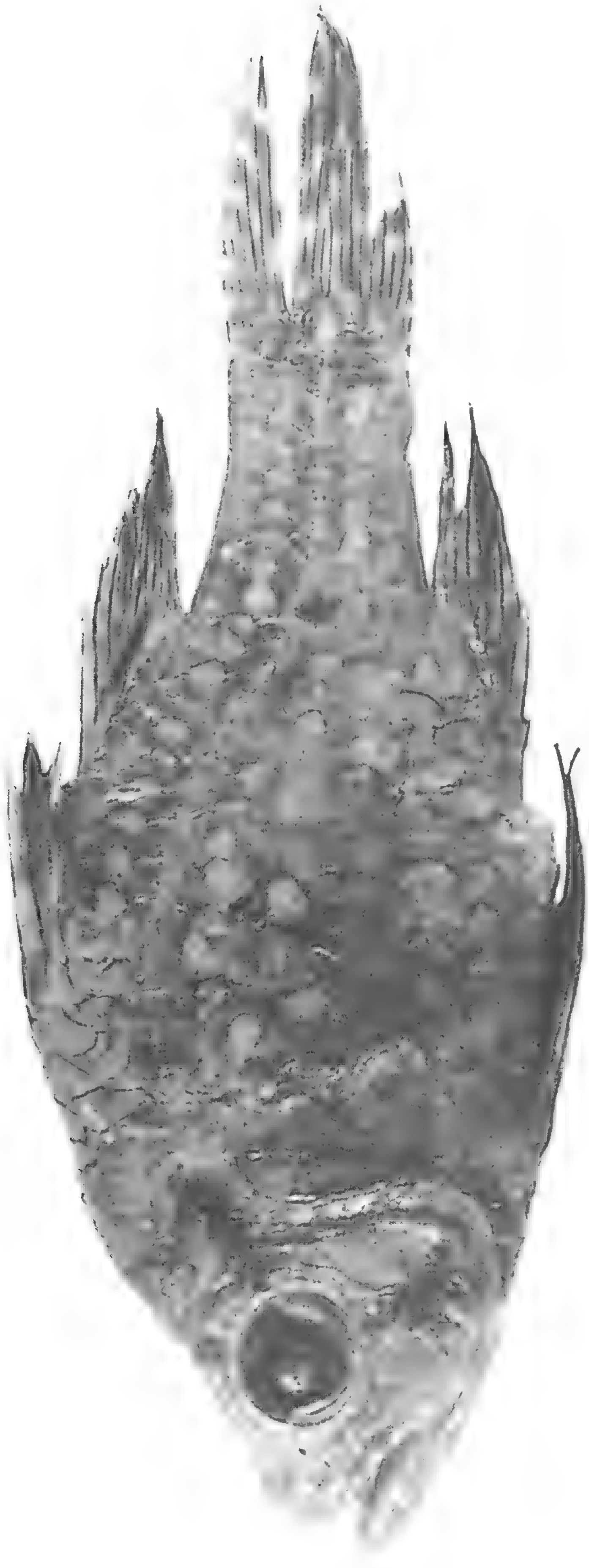

Fig. 1.—*Apogon albimaculosus* holotype (AM 1B. 8347), 66 mm S.L.

Apogon albimaculosus new species
Fig. 1, Fig. 2, Table 1.

MATERIAL EXAMINED: Holotype, AM IB. 8347, female specimen, 66 mm S.L., trawled at night between Gloucester Island and Bowen (20°01'S, 148°15'E), north Queensland, 10 fathoms (18.3 metres), September 1967, collector G. Coates.

Paratypes, AM I. 16232-001, two female specimens, 58 and 63 mm S.L. (smaller specimen is cleared and stained in Alizarin Red-S), trawled at night 3 miles north of Magnetic Island, Townsville (19°100'S, 146°50'E), north Queensland, 12 fathoms (21.9 metres), June 1969, collector G. Coates; AM I. 15557-287, male specimen, from *Rama* station 410, 17°24'50"S, 140°09'45"E, Gulf of Carpentaria, 5½ fathoms (10.1 metres), 27 November 1963, collector I.S.R. Munro; CSIRO F. & O. A. 2521 female specimen, 58 mm S.L., from *Kestrel* station 13, ca. 10 miles northeast of North Point Islet, off Groote Eylandt (14°00'S, 136°36'E), Gulf of Carpentaria, 15 fathoms (27.4 metres), 4 September 1963, collector I.S.R. Munro; AM I. 16895-001, female specimen, 61 mm S.L., trawled north of Yule Island (8°49'S, 146°31'E), Papua, 20 fathoms (36.6 metres), 13 February 1971, from FRV *Rossel*, collector R. Pyne; AM I. 16896-001, male specimen, 55 mm S.L., trawled north of Yule Island (8°49'S, 146°31'E), Papua, 18 fathoms (32.9 metres), 13 November 1970, from FRV *Maragili*, collector R. Pyne; AM I. 17818-001, male specimen, 65 mm S.L., from Daru Roads, northeast of Daru and Bristow Islands (9°08'S, 143°14'E), western Papua, 4 fathoms (7.3 metres) 19 January 1961, from FRV *Tagula*.

DIAGNOSIS: The combination of the following characters distinguishes the new species from other species of *Apogon:* eight spines in first dorsal fin; eight well-formed gill rakers; preopercular ridge smooth, edges crenulate to weakly serrate; elongate ventral fins 1 to 1.4 in head length; rounded caudal fin; a short row of villiform teeth on palatines; 17 to 19 elements in pectoral fin; no supramaxilla; first and second hypural bones fused; well-developed crests on frontals; lateral line complete; scales ctenoid; colour in preservative generally brown with rows of large black-edged pearly spots along body and rows of white spots on fins.

DESCRIPTION: D. VIII; I, 9. A. II, 8. P. ii, 14, ii (ii, 13, ii to ii, 14, iii). V. I, 5. C. (3-4) ii, 8+7, ii (3-4). L. lat. 23, plus one over base of caudal rays (21 to 23, plus 1 or 2). L. tr. 2+6. Predorsal 5 (4 to 5). Gill rakers on first branchial arch (2) 1+1+6 (5), [(2) 1+1+6 (3) to (3) 1+1+6 (5), mean (2.6) 1+1+6 (4.2)], total 13 to 16. Vertebrae 24. Branchiostegals 7.

Body deep, 2.3 in S.L. (2.1 to 2.5, mean 2.3); upper profile slightly more convex than lower profile. Head fairly large, 2.6 (2.3 to 2.6, mean 2.5) in S.L. Snout short and bluntly rounded, 1.5 (1.3 to 1.6, mean 1.5) in eye. Mouth slightly oblique; jaws equal, though lower heavier. Small knob at symphysis of lower jaw. Eye in head 3.4 (3.2 to 3.8, mean 3.5). Maxillary reaches to middle of eye or beyond, upper edge concealed by suborbital when mouth closed. Maxillary expansion 1.8 in eye diameter (1.6 to 2.1, mean 1.8). Supramaxilla absent. Posterior nostril tear-shaped, close to front of eye and in line with centre of pupil; anterior nostril in short tube, close to upper jaw and about midway between front border of eye and snout tip. Suborbital entire; orbital rim entire, undulate below. Preopercular ridge entire; preopercular margin varies from crenulate to finely serrate along posterior and ventral limbs (fig. 1). A weakly developed spine on operculum.

Gill rakers slender and spiculate, rudiments densely so. Gill raker at angle 1.2 (0.8 to 1.4, mean 1.1) longer than longest gill filament, and 2.4 (2.2 to 4.2, mean 2.9) in eye diameter.

Band of fine, pointed teeth on both upper and lower jaws: 6 or 7 series in band on

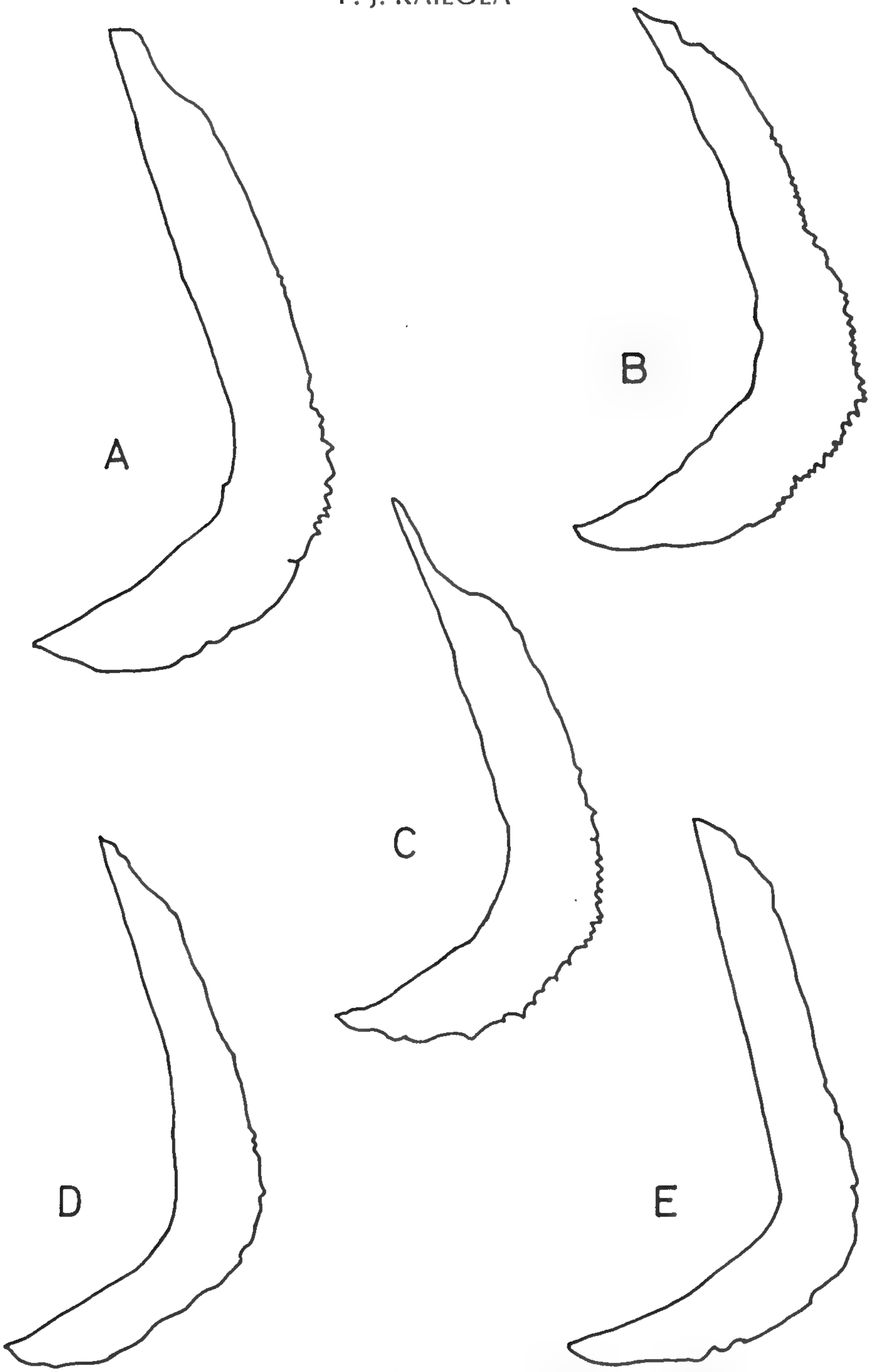

Fig. 2.—Variation in the serrature of the preopercular margin in *Apogon albimaculosus*. *A. Holotype. AM 1B. 8347. 66 mm S.L. B. Paratype. AM I 15557-287. 57 mm S.L. C. Paratype. AM I. 16232-001. 58 mm S.L. D. Paratype. CSIRO F. & O. A. 2521. 58 mm S.L. E. Paratype. AM I. 16895-001. 61 mm S.L.*

dentary, 9 in premaxillary band. No teeth at symphyses; in upper jaw length of edentulous symphysis slightly less than width of teeth band. Three to four series of villiform teeth on vomer in shape of inverted "V". Few teeth on front of palatine bones, varying from 2 or 3 rudiments to one row of 7 or 8 fine, pointed teeth. No teeth on tongue and ectopterygoids. One large and several smaller patches of small conical teeth on pharyngiobranchial bones at back of mouth. Tongue smooth, rounded in female specimens, but tip upturned and excavated in male specimens.

Interorbital broad, concave on each side of central flat ridge, 1.2 (1 to 1.4, mean 1.2) in eye. Predorsal profile rises gently to above posterior half of eye, then arches to dorsal fin origin. About 8 longitudinal folds of skin on nape.

Ctenoid scales cover body and opercular bones, also one embedded scale on temporal region directly above preopercular ridge. Scales with 8 to 10 basal radiating striae and 5 rows of denticles on posterior margin. Lateral line complete, originating at upper insertion of operculum and following curve of back, becoming straight on caudal peduncle.

Two dorsal fins, almost united basally by low vestigial membrane. First dorsal fin originates directly above edge of operculum. First dorsal spine twice (2 to 2.3, mean 2.1) in length of second spine; third spine twice (1.9 to 2.3, mean 2.1) length of second spine. Third spine strongest, slightly longer than fourth spine, and 1.9 (1.5 to 2, mean 1.8) longer than eye diameter. Spines decrease regularly in length to minute eighth spine. In holotype and three paratypes, eighth spine clearly visible, but enveloped in skin close to dorsal profile in remainder of paratypes. Dorsal membrane scalloped, spine tips free.

Spine of second dorsal fin 1.3 (1.2 to 1.5, mean 1.3) times eye diameter. Second or third dorsal ray longest, 1.6 length of spine (1.4 to 1.8, mean 1.6). Soft dorsal outline truncate, fin higher than spinous dorsal.

Anal fin outline truncate to rounded. Second anal spine subequal to soft dorsal spine; longest anal rays slightly longer than longest dorsal rays.

Pectoral fins narrow and rounded, longest ray 1.6 in head length (1.6 to 1.7, mean 1.7). First simple ray very short, second simple ray only slightly shorter than longest divided ray.

Ventral fins close together and elongate, subequal (1.1) to head length (1 to 1.4, mean 1.2 in head length), and 1.5 longer than pectoral fin (1.2 to 1.6, mean 1.5). Ventral fins extend at least as far as vent, usually further, in one male specimen to fifth anal ray. Varying length of ventral fin apparently not sexually related(see table 1).Inner ventral ray united to abdomen by membrane, best developed in paratype (I. 16895-001) where membrane extends halfway along inner ray. Two enlarged scales between bases of ventral fins (lost in some specimens); second the largest, ovate, extending two-thirds distance along ventral spine and obscuring inner membrane.

Least depth of caudal peduncle in peduncle length measured from anal fin 1.5 (1.1 to 1.4, mean 1.3). Caudal fin rounded, with 15 divided rays, two developed simple rays and three or four rudimentary rays on upper and lower edges.

Colouration of types after preservation in 45% isopropyl alcohol fawn, mottled with brown. Head and nape darker; brown alternating blotches across lips, isthmus, chin and radiating from eyes. Iris dark grey; brown patches visible on eye in some specimens. Broad, dark brown band extends obliquely upwards from hind border of eye to origin of lateral line. Second brown band extends from lower hind border of eye across cheek and maxillary expansion to isthmus. This band not readily apparent in some specimens.

Longitudinal rows of distinct, large white black-edged spots on body, roughly following centres of scale rows. The two or three rows above lateral line and that directly

Table 1. Measurements in millimetres of the holotype and paratypes of *Apogon albimaculosus* n. sp.

CHARACTER	HOLOTYPE IB. 8347	PARATYPES I. 16232-001	I. 16232-001	I. 16895-001	I. 16896-001	I. 15557-287	A. 2521	I. 17818-001
Standard length	66	63	58	61	55	57	58	65
Depth	29.0	29.5 (belly swollen)	23.0	26.2	26.4	26.4	24.1	29.6
Head length	25.4	25.1	22.3	23.2	22.8	23.0	22.9	28.7
Eye diameter	7.5	7.1	6.5	6.8	7.2	6.0	6.1	8.4
Snout length	4.9	5.0	4.6	4.9	5.1	4.7	4.5	5.2
Interorbital	6.4	6.1	5.8	5.9	5.6	5.8	5.5	6.2
Maxillary expansion	4.1	4.0	3.2	4.2	3.8	3.7	3.7	3.9
First dorsal spine	3.6	3.5	2.9	2.7	2.4	2.4	1.4 (broken)	2.6
Second dorsal spine	7.2	7.1	6.3	5.9	4.7	5.5	5.1	5.6
Third dorsal spine	14.2	13.5	12.8	13.3	11.0	11.7	10.6	12.7
Fourth dorsal spine	13.7	13.6	11.9	12.1	10.4	11.2	10.1	11.7
Spine of second dorsal fin	9.9	10.2	9.6	8.9	8.3	8.5	8.3	10.0
Second anal spine	10.2	10.0	9.6	9.5	8.7	9.3	7.2	10.4
Longest dorsal ray	16.3	14.9	13.8	14.9	15.1	14.2	14.8	15.0
Longest anal ray	17.0	15.8	14.8	16.7	15.0	14.5	14.6	15.2
Pectoral fin length	15.8	14.6	13.6	14.4	15.0	13.5	13.5	17.0
Ventral fin length	23.3	23.1	19.1	22.9	19.8	18.6	20.3	20.2
Caudal fin length	21.3	23.1	19.3	21.6	20.9	19.7	18.7	21.7
Length of caudal peduncle (from last anal ray)	14.4	13.1	13.0	11.8	10.3	11.5	12.4	12.7
Least depth of caudal peduncle	10.6	9.5	8.4	9.8	8.5	9.2	9.1	10.3
Length of edentulous symphysis in upper jaw	0.9	0.9	0.5	0.6	0.6	0.7	0.6	0.8
Width of band of teeth in upper jaw	1.1	1.1	0.8	1.0	0.9	1.0	1.0	1.0
Length of gill raker in angle	3.1	3.0	2.9	2.8	1.9	2.0	1.6	2.0
Length of gill filaments	2.6	2.8	2.6	2.3	1.8	2.1	2.4	2.4
Head length without snout	20.0	19.9	17.0	18.7	18.2	19.0	17.7	21.0
Base of anal fin	10.3	9.4	8.0	9.9	8.9	8.1	9.2	10.4
Base of first dorsal fin	16.0	14.2	11.8	14.0	13.5	14.0	13.5	15.3
Base of second dorsal fin	11.2	10.2	9.7	9.1	9.6	9.5	10.6	11.0
Ventral spine length	10.8	11.4	10.6	11.1	10.1	10.0	9.1	10.6
Length of median ventral scale	6.5	absent	absent	absent	5.8	6.2	absent	6.7

below follow its course to tail base. Four or five shorter, horizontal rows of spots on flanks. First of these terminates opposite end of soft dorsal fin; remainder successively decrease in length. Last rows of spots runs along breast terminating halfway between ventral fin base and vent. Lower rows often represented by only one or two spots.

Fins dark brown except hyaline pectorals. White spots on all fins roughly forming 3 or 4 longitudinal bands. Fewer white spots on spinous dorsal; rows of spots on caudal fin convex, following outline of fin. Large semicircular, dark brown or black ocellus basally on soft dorsal fin, between first and sixth rays. This blotch sometimes with white or cream margin; sometimes covered with milky wash. Similar dark blotch present in some specimens on anal fin, although not as prominent as dorsal ocellus. Except pectorals, black on margins of all fins and over distal half of ventrals. Peritoneum white to silvery with small, scattered black spots.

Life colours of the holotype are as follows: Body brown, darker above and in scattered patches on body and head. Iris yellow; yellow highlights on operculum. Spots on body white outlined in black. Pectoral fins pale yellow; all other fins brown with rows of yellow spots; anal and ventral fins darker distally. Black ocellus on soft dorsal fin covered by white wash extending over basal third of fin.

REMARKS

This species is included in the genus *Apogon* and subgenus *Nectamia* as outlined by Fraser (1972). However, *A. albimaculosus* differs from other members of *Nectamia* in the following characters: (i) posterior and ventral edges of the preoperculum vary from practically smooth to weakly serrated (figure 1), not fully serrated as in *Nectamia;* (ii) frontals with well-developed crests (usually not with developed crests in *Nectamia*); (iii) only four hypurals, one and two being fused (usually five hypurals in *Nectamia*, though in specimens of *A. margaritophorus* Bleeker examined by Fraser, the first two hypurals were fused). Other characters of *albimaculosus* such as the scarcely developed palatine tooth patch, eight dorsal fin spines, absent supramaxilla and well-developed basisphenoid agree with *Nectamia. Apogon* Lacépède is the closest related subgenus to *Nectamia*. However, *Apogon* has six spines in the first dorsal fin, 2 predorsal scales, and no uroneurals, which effectively exclude *A. albimaculosus.*

Fraser (*in litt.*, 1974) after examining the cleared and stained paratype (AM I. 16232-001) and the 61 mm paratype (AM I. 16895-001) has suggested several possible relationships for *A. albimaculosus:* (a) it is related to the *A. taeniatus* Cuvier and Valenciennes group in *Nectamia;* (b) it is related to *A. chrysurus* Ogilby and another undescribed species; (c) it is related to both (a) and (b); (d) it represents a distinct group and has no close relatives. At least from the description given by Munro (1960), *A. chrysurus* differs from *A. albimaculosus* significantly in possessing bands of villiform teeth on the palatines and a finely serrated hind margin to the preoperculum, though the lower margin and ridge of the preoperculum are entire.

Another species, *Apogon brevicaudatus* Weber from the Aru Islands, Queensland and Western Australia, not only has similar meristics to *A. albimaculosus*, but has seven or eight dark brown longitudinal bands on the body, and basal black ocelli on the soft dorsal and anal fins (Weber and de Beaufort, 1929). The ventral fins are also elongate, 1.3 longer than the pectoral fins in a 135 mm S.L. syntype (Zoölogisch Museum Amsterdam no. 101.127) and equal to the head without snout. However the presence of well-toothed palatines, a strongly serrated preopercular margin, irregularly serrated orbital rim, and large serrae on the angle of the preopercular ridge clearly separate this species from *A. albimaculosus.*

The holotype (AM IB. 8347) of *A. albimaculosus* and the 61 and 63 mm S.L. paratypes (AM I. 16232-001, and I. 16895-001) are all gravid females with egg masses extruding from the vent (as was AM I. 16232-001, 58 mm S.L. paratype, before clearing and staining). There are three male paratypes (AM I. 16896-001, I. 15557-287 and I. 17818-001). Each have an excavated and scalloped tongue tip, and one specimen (I. 17818-001) has a greatly distended throat. The male paratypes also have a relatively smaller, compact body with slightly higher depth. A small pointed papilla is situated behind the vent. Paratype CSIRO F. & O. A. 2521 is female, and has the heavier body of the other females.

Apogon albimaculosus is a benthic species, known from the Gulf of Papua to the Gulf of Carpentaria and tropical north Queensland. It is found in muddy and clear shallow coastal waters.

The species name, *albimaculosus,* refers to the distinctive rows of large white spots on the body.

ACKNOWLEDGEMENTS

I offer sincere thanks to those persons who assisted me in many ways. Thomas H. Fraser (J. L. B. Smith Institute of Ichthyology, Rhodes University) examined two paratypes and suggested possible relationships for the species. John R. Paxton (Australian Museum, Sydney) and Dr. Fraser both critically read the manuscript and suggested many improvements. Specimens of *Apogon albimaculosus* kindly lent by Ian S. R. Munro (C.S.I.R.O., Cronulla) and Dr. Paxton from collections in their care are included in the type series. H. Nijssen (Zoölogisch Museum, Amsterdam) examined the syntypes of *Apogon brevicaudatus* on my behalf. Douglass F. Hoese (Australian Museum), Ernest A. Lachner (Smithsonian Institution, Washington) and B. Hamer (Queensland Museum, Brisbane) provided various information on apogonids in their collections. Life colours of the new species were described by George Coates of Townsville and the photograph was taken by the Department of Information and Extension Services, Port Moresby.

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POLYCHAETA FROM SOUTHEASTERN AUSTRALIA. 1. ACROCIRRIDAE BANSE, 1969, FROM VICTORIA AND NEW SOUTH WALES

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SUMMARY

Acrocirrus aciculigerus n. sp. and *Macrochaeta australiensis* n. sp. (Acrocirridae) are described, and keys to all known species of each genus are given. This is the first record of *Macrochaeta* in Australia.

INTRODUCTION

The Acrocirridae was established by Banse (1969). It contains two genera, *Acrocirrus* Grube, 1872, and *Macrochaeta* Grube, 1850, which were previously included in the Cirratulidae (see Day, 1967). Acrocirrids are separable from cirratulids because they have multiarticulate notosetae and simple or composite falcigers in the neuropodia. Cirratulids have simple capillary setae and acicular spines. Acrocirrids are further characterised in having ventrally grooved palpi, the prostomium situated on top of the peristomium and branchiae generally restricted to four anterior segments. Distinct parapodial lobes may be present. The Acrocirridae shares a number of similar characteristics with the Flabelligeridae. For example, both families have a buccal bulb, composite setae, acicula and the blood pigment, chlorocruorin (Mesnil, 1899; Banse, 1969).

Acrocirrids have been reported from numerous localities in the northern hemisphere, and are known from New Zealand and Antarctica in the southern hemisphere. This paper describes a new species each of *Acrocirrus* and *Macrochaeta*. Although Bennett (1966) records the former genus from New South Wales, this is the first record of the latter genus in Australia. Specimens of *Acrocirrus* were obtained from the Australian Museum, Sydney, New South Wales; specimens of *Macrochaeta* were obtained from Western Port (Westernport Bay Environmental Survey (WBES), Fisheries and Wildlife Division, Melbourne, Victoria), and from Point Gellibrand, Port Phillip Bay, Victoria. Type material has been deposited in the National Museum of Victoria, Melbourne (N.M.V.); the Australian Museum, Sydney (A.M.); and the Allan Hancock Foundation, University of Southern California, Los Angeles, California, USA (AHF).

Records of The Australian Museum, 1976, **30**, 137–149, Figures 1–5.

SYSTEMATICS

Family **Acrocirridae** Banse, 1969

Genus **Acrocirrus** Grube, 1872

Acrocirrus aciculigerus n. sp.

MATERIAL EXAMINED: New South Wales, Long Reef, Collaroy, Sydney, April 1962, I. Bennett, collector-HOLOTYPE (AM W. 4908); Long Reef, Collaroy, Sydney, mid-tide level, in sand under stones, January 1964, I. Bennett, collector-PARATYPES (AM W. 4907).

DIAGNOSIS: A large *Acrocirrus* species with segments 1-4 ventrally fused; neurosetae from segment 4; notosetae from segment 6; a raised transverse annulus present between the parapodia of each segment.

DESCRIPTION: One specimen complete; 4 incomplete posteriorly. One of latter specimens an anterior fragment, and not included in following determinations. The remaining 3 worms lack pygidia and probably 10-15 posterior segments. Average length of 4 specimens 66 mm; width 5.1 mm. Average number of segments 107; complete specimen has 114. Holotype 66 mm long and 5.5 mm wide; with 104 segments of which 101 setigerous. Body semi-circular in cross section. Ventrum flat and midventrally grooved. A raised transverse annulus connects parapodia of each segment; annulus midventrally incomplete. A few minute epidermal papillae located on each segmental annulus. The body colour of specimens in alcohol grayish to chocolate brown.

Prostomium pentagonal in shape, and 1.2 times longer than wide (figs 1a and b). Anterior median margin pointed. This projection continuous with an anterior dorsoventral median ridge. Ridge located between each palp; ventrally it forms midventral upper lip of mouth. Palpi probably midventrally grooved; all have become detached and lost from this material. Prostomium divided into an anterior and posterior lobe by a transverse ridge (fig. 1a). Eyes not observed in anterior lobe. Three pairs of eyes present on posterior lobe (fig. 1a). Two pair present on anterolateral margin; the other more medially placed. Posterior pair of anterolateral eyes largest. Each eye of this pair elliptical. Anterior pair of anterolateral eyes and medial pair about same size. Each eye of these pairs circular, about one-fifth the size of a large eye. A middorsal cap present on posterior prostomial lobe (figs 1a and b). Cap divided into 2 parts by transverse furrow. Posterior region further divided by a middorsal longitudinal groove. A transparent rim not observed along the posterior prostomial margin.

Peristomium dorsally complete (fig. 1a), but divided into 7 "scutes" that appear to imbricate with one another. Three lateral and a single dorsal scutes present. Peristomium terminates at base of each palp, but is continuous with the anterolateral and posterior lips of the mouth. Mouth a transverse slit. A pair of U-shaped, cushion-like ridges present on anterolateral lips (figs 1a and b). The posterior lip crenulate; lacks papillar swellings.

Proboscis a smooth eversible ventral sac consisting of a buccal mass and pharynx.

All thoracic and abdominal segments wider than long. Twelve thoracic segments present; 10 setigerous. Segment 1 (=peristomium) ventrally fused with segments 2-4. These 4 segments ventrally distinguishable from segment 5 by an intersegmental groove. A distinct cirrus present below each branchia of segment 3. These cirri conical, distally blunt.

Inflated parapodial lobes present on thoracic and abdominal segments. These lobes located at ventrolateral terminations of each segmental annulus (fig. 1b). Notopodial and neuropodial cirri absent. All parapodia after first 2 biramous. First 2 setigers (segments 4-5) contain neurosetae only.

With exception of segment 14, thoracic and abdominal parapodia basically similar (figs 2a through e). Anterior thoracic segments differ from posterior thoracic segments in

placement of papillae (figs 1b and 2a). Segments 4-6 have 18-20 small digitate interramal papillae per parapodium (fig. 1b); segments 10-12 have around 15. Segments 4-9 lack a large conical interramal papilla that is present on segments 10-12 (fig. 2a). Inferior neuropodial papillae absent from segments 4-5; a single inferior papilla present on each parapodium of segments 6-9; two present on segments 10-12. The parapodia of segments 7-9 differ from other thoracic parapodia because each has a single postsetal neuropodial papilla (fig. 2a).

Segment 14 modified (figs 2b and c). A pair of smooth ventrolateral ridges present at anterior margin of this segment (fig. 2b). A transverse depression located behind each ridge (fig. 2c). Each depression gives way to an inflated neuropodial lobe containing well developed acicula. A single interramal and inferior papilla present.

The parapodia of segment 50 resemble those of the posterior thorax (fig. 2d). About 10-14 interramal papillae present. The large interramal papilla blunt and ovoid. Two inferior neuropodial papillae present; the inferiormost smallest.

The parapodia of segment 100 reduced in size (fig. 2e). About 5-8 small interramal papillae present. The single interramal papilla stout and hemispherical. A single large, flattened, glandular inferior neuropodial papilla present.

The pygidium terminal (fig. 2f). Anal papillae appear to be absent. The epidermal tissue of caudal segments highly glandular and areolate.

Notosetal fascicles laterally positioned in all thoracic and abdominal setigers. They are embedded into parapodial lobes, and are arranged in dorsoventral rami (figs 2a, d and e). Twelve notosetae per fascicle present in segment 9; 16 in segment 14; 25 in segment 50; 8 in segment 100. Notosetae 3 mm long, cylindrical and taper to sharp distal points. Superior notosetae longest, basally smooth and distally partitioned (fig. 2g). Inferior setae smaller, distinctly partitioned. Transverse partitions 1-1.5 μm apart. Setal margins serrated (fig. 2g).

Thoracic and abdominal neurosetal fascicles ventrolaterally positioned (figs 2a, d and e). All neurosetae except those of segment 14 composite and distally falcate (figs 2h and i). Appendages of thoracic neurosetae long and face posteriorly; those of abdomen shorter and face anteriorly. Five neurosetae per fascicle present in segment 9; 4-6 in segment 50; 4 in segment 100.

From 15-20 acicula per notopodium and 9 per neuropodium present (figs 2j and k). All spindle shaped. Neuroacicula longer than notoacicula. Latter project through body wall; neuroacicula do not.

From 3-6, usually 4-5 falcate acicula present in each neuropodium of segment 14. All face anteriorly, cylindrical in cross section, tapering to sharp points (fig. 2l).

Branchiae number 4 pairs; present on segments 2-5 (fig. 1b). All branchiae detached from these specimens, but their locations revealed by branchial scars. Each branchia about 10 mm long and 1 mm wide, basally elliptical in cross section, and circular distally. All attenuate to blunt tips.

RELATIONSHIPS: *Acrocirrus aciculigerus* resembles *A. frontilis* Grube, 1872, *A. heterochaetus* Annenkova, 1934, *A. okotensis* Imajima, 1963 and *A. incisa* Kudenov, 1975, because acicular hooks are present on segment 14. *A. aciculigerus* differs from these species because three to six acicula per fascicle are present, and the acicula are not distally enlarged. *A. frontilis, A. heterochaetus, A. okotensis* and *A. incisa* have one distally enlarged, beaked aciculum per fascicle. All of these species have 4 pairs of branchiae distributed from segments 2 through 5, and not 6 as described by Kudenov (1975) for *A. incisa.*

DISTRIBUTION: *Acrocirrus aciculigerus* has been collected from one locality in New South Wales; it occurs in sand under stones.

KEY TO SPECIES OF *Acrocirrus*
(modified from Banse, 1969, p. 2599)

1.	Segment 14 with acicular hooks	2
—	Segment 14 without acicular hooks	6
2.	Three to six acicula per parapodium of segment 14	*A. aciculigerus* n. sp.
—	One aciculum per parapodium of segment 14	3
3.	Abdominal neurosetae as simple falcigers	*A. okotensis* Imajima, 1963
—	Abdominal neurosetae as composite falcigers	4
4.	Notopodial cirri present	*A. frontilis* (Grube, 1860)
—	Notopodial cirri absent	5
5.	Parapodial lobes incised	*A. incisa* Kudenov, 1975
—	Parapodial lobes entire	*A. heterochaetus* Annenkova, 1934
6.	Abdominal neurosetae as simple falcigers	*A. trisectus* Banse, 1969
—	Abdominal neurosetae as composite falcigers	7
7.	Neurosetae from fourth branchiferous segment	*A. crassifilis* Moore, 1923
—	Neurosetae from third branchiferous segment	8
8.	Notosetae from setiger 2	*A. uchidai* Okuda, 1934
—	Notosetae from setiger 3	9
9.	Upper face of prostomium smooth	*A. muroranesis* Okuda, 1934
—	Upper face of prostomium ridged	*A. validus* von Marenzeller, 1879

Genus **Macrochaeta** Grube, 1850
Macrochaeta australiensis n. sp.
figs. 3-5

MATERIAL EXAMINED: Victoria, Point Gellibrand, Port Phillip Bay, approx. 37°52.4'S, 144°54.25'E, low midintertidal tidepool, attached to bottom of basalt boulders, boulders in silt, September 1974, J. D. and K. A. Kudenov, collectors-HOLOTYPE (NMV G2521) and PARATYPES (NMV G2522; AM W. 6969; AHF Poly 1125). Westernport, the following PARATYPES from WBES Stations: 1725, 9 m, sand, November 1973, R.V. *Capitella* (NMV G2525); 1729, 23 m, sand, November 1973 (NMV G2523); 1737, 12 m, silty-sandy-clay, November 1973 (NMV G2524); 1740, 8 m, silt, November 1973 (NMV G2526); 1702, low intertidal zone, silty clay, January 1974, R.V. William Buckland (AM W. 6967); 1708, low intertidal zone, silty clay, January 1974 (AM W. 6968); 1709, low intertidal zone, sandy clay, January 1974 (AHF Poly 1122); 1716, low intertidal zone, mud, January 1974 (AHF Poly 1123); 1719, low intertidal zone, clay, January 1974 (AHF Poly 1124).

DIAGNOSIS: *A. Macrochaeta* species up to 20 mm long and 50 segments. Segment 1 not dorsally visible. Four pairs of gills. One or two notosetae and generally one composite falciger each per notopodium and neuropodium. Reversal of neurosetal hooks generally from segment 13 (sometimes from segments 11 or 12). Eleven continuous transverse rows of epidermal papillae per segment.

DESCRIPTION: A total of 41 specimens examined. Observations made on live specimens from Point Gellibrand; Westernport material preserved. Average length of 10 complete specimens 10.8 mm; width 0.7 mm. Smallest 5 mm long, 0.3 mm wide. Largest specimen designated as holotype, and is 20 mm by 1.1 mm. Generally 40 segments in complete specimens; holotype has 50 segments, of which 47 setigerous. Body surface papillate. All papillae present in continuous transverse rows that encircle body (fig. 3). About 11 such rows per segment. Papillae in the row connecting each pair of parapodia particularly well defined. Body surface generally obscured by silt trapped between

epidermal papillae. In life body colour pinkish-orange; palpi translucent brown; branchiae reddish orange. The body greenish-yellow when preserved in Bouin's fixative; palpi and branchiae brown.

The prostomium broadly petaloid in shape, 1.1 times longer than wide (figs 4a and b). The anterior margin pointed. This projection continuous with a narrow anterior dorsoventral median ridge (fig. 5a). This ridge lies between each palp; ventrally it forms midventral anterior lip of mouth. Palpi emerge from anterolateral positions just in front of mouth (figs 3 and 5a). Each palp has a midventral, ciliated longitudinal groove, and is 1.5 mm long and 0.2 mm wide. Distance separating two palps equals thickness of anterior dorsoventral ridge. Proximal inner margins of each palp touch one another. Surface of prostomium divided into an anterior and posterior lobe by a transverse ciliated ridge (figs 4a and b). A single pair of eyes present on anterior lobe of holotype. Each eye small, circular, and embedded into body wall. Two pair of eyes present on posterior lobe (figs 4a and b). The anterior pair largest, lies just behind transverse ridge. Each eye elliptical, and located at lateral prostomial margin. The posterior pair about one-half the size of anterior pair of this lobe. Each eye circular and more medially placed. Not all specimens have three pairs of eyes. Most have two pair on posterior lobe. Posterior lobe middorsally divided by a wide, shallow depression (fig. 4a). A middorsal pigment spot present at posterior margin of this depression figs 4a and 5a). Depression and pigment spot not visible in all specimens. Posterior margin of prostomium circumscribed by a narrow transparent rim that is middorsally incomplete (fig. 4a).

Peristomium reduced to a low collar; dorsally incomplete (figs 4a and 5a). Laterally well defined, wider (fig. 4b). Peristomium terminates at base of each palp, but is continuous with anterolateral and posterior lips of mouth. Mouth a ventral transverse slit. A pair of U-shaped ridges present on anterolateral lips (fig. 5a). Each ridge resembles a cushion; and is located just below each palp. A pair of large circular papillae present on posterior lip. Each papilla located just opposite each cushion-like elevation of anterolateral lips.

Proboscis not fully everted in these specimens. Ventral margin of lip crenulate, and its inner surface folded (fig. 5a).

All segments of thorax and anterior half of abdomen wider than long; those of posterior abdomen longer than wide. Generally 12 thoracic segments present; 9 setigerous. Two specimens differ: one has 10 and other has 11 thoracic segments. Segment 1 (=peristomium) fused ventrally with segment 2. These two segments distinguishable from segment 3 by a segmental groove. A row of spherical epidermal papillae present on anterior margin of segment 2. A distinct cirrus present just below each branchia of segment 3 (figs 4a, b and 5a). Cirri conical and distally blunt.

All parapodia biramous. Notosetae and neurosetae begin from segment 4. The positions of parapodia gradually change along body axis. Parapodia of thoracic segments 4-7 on anterior half of each segment; those of remaining thoracic segments and abdominal segments 13-19 on the middle of each segment; parapodia on posterior half of segments 20-50. Notopodial and neuropodial cirri absent. Notopodial lobes absent. All notosetal fascicles surrounded by raised collars (figs 5b, c and d). Neuropodial lobes present on thoracic setigers 1-9 (segments 4-12); entire and mound shaped (figs 4a and 5b). Neuropodial lobes absent from abdominal setigers. Distinct neuropodial collars present on abdominal segments 13-17. They are present, but sometimes indistinct, on the remaining abdominal segments (figs 5c and d). Conspicuous interramal papillae present on all setigerous segments. About 5 elliptical interramal papillae per parapodium present on setigers 1-3 (segments 4-6) (figs 3 and 4a). Distally inflated interramal papillae present thereafter. All cylindrical in cross section. Four such papillae present on setigers 4-12

(segments 7-15) (fig. 5b); 3 on setigers 13-17 (segments 16-20); 2 to 3 on setigers 18-35 (segments 21-38) (fig. 5c); 1 to 2 from setiger 36 (segment 39) to end of body (fig. 5d).

Pygidium truncate, and anus terminal (figs 5e and f). Pygidium consists of 8-10 flattened papillae. Anal appendages absent; a row of epidermal papillae present on lateral and dorsal surfaces of pygidium.

All setal fascicles deeply embedded into body wall. Notosetal fascicles laterally positioned in all thoracic and abdominal setigers (figs 5b, c and d). Notosetae cylindrical in cross section, and taper to fine points. They are longitudinally striated; basal striae are weakly defined. Transverse partitions 1.5 μm to 2 μm apart (fig. 5g). These partitions almost absent basally; best developed distally. Serrated margins inconspicuous (fig. 5g). Notosetae of setigers 1-4 1.2 mm long; posteriorly they increase to 2 mm. Generally 1-2 notosetae per fascicle present in all thoracic and abdominal notopodia.

Neurosetal fascicles ventrolaterally positioned in all thoracic and abdominal setigers (figs 5b, c and d). All neurosetae composite falcigers. Appendages of thoracic neurosetae long and face posteriorly (fig. 5h); those of the abdomen shorter and face anteriorly (fig. 5i). Generally one (occasionally 2) setae per neuropodium present in all thoracic and abdominal setigers. Three specimens differ because a single neuroseta present on left side of segment 3, but absent from right side. Notosetae absent from segment 3.

There are 2-3 acicula per notopodium, and 3-4 per neuropodium (figs 5j and k). All spindle shaped. Notoacicula project through body wall; neuroacicula do not.

Branchiae number 4 pairs; present on segment 2-5 (figs 3, 4a and b). Each branchia elliptical in cross section, elongate, distally blunt. Three longitudinal ciliary bands present on inner surface of each branchia (fig. 3). An additional ciliary patch present on outer basal surface (fig. 3). Small dome shaped papillae 3 μm wide and 2 μm high present on each branchia.

There are 4 types of epidermal papillae: digitate; distally inflated; elliptical; and dome shaped. Digitate papillae the most abundant; found primarily on continuous transverse rows that encircle body (fig. 3). They are about 20 μm long and 5 μm wide (fig. 5a). Distally inflated papillae found in rows that connect pairs of parapodia, and as interramal papillae (figs 3 and 5c). They are the largest kind of papilla, measuring from 30-50 μm long and 10 μm wide. Elliptical papillae occur on anterior segments, and are 5-8 μm high and 5 μm wide (fig. 5a). As noted above, dome shaped papillae occur on branchiae.

Specimens collected in January contained gametes. Sperm platelets, morulae and spermatozoa were found in male specimens. Headpiece spherical, and measures 2 μm in diameter. Acrosome appears flattened. Polygonal primary oocytes with large germinal vesicles present in females. Oocytes 125 μm in diameter; germinal vesicles about 40 μm; nucleoli around 8 μm. The thin outer membrane of oocytes sculptured.

RELATIONSHIPS: *Macrochaeta australiensis* resembles *M. clavicornis* (Sars, 1835), *M. papillosa* Ehlers, 1913, and *M. pege* Banse, 1969, because all have four pairs of branchiae, and composite neurosetae in all setigers. The most distinctive feature of *M. australiensis* is the arrangement of epidermal papillae into transverse rows. The papillae of the other three species appear to be randomly distributed. The spermatozoa are primitive (Franzen, 1956).

An important systematic criterion in this genus is the degree to which anterior segments are reduced (Banse, 1969). Within the above subgroup of four species, *M. clavicornis* is the only one in which segment 1 is dorsally complete. *M. papillosa* differs because both segments 1 and 2 are not dorsally visible. *M. australiensis* and *M. pege* are similar because segment 1 is dorsally incomplete. This segment is laterally visible in both

species. *M. pege* has 55 segments; *M. australiensis* has around 50. The prostomium of *M. australiensis* is broadly petaloid; it is circular in *M. pege*. The latter species lacks parapodial lobes; *M. australiensis* has distinct neuropodial lobes in the thorax. Interramal papillae are present in *M. australiensis;* they are absent in *M. pege*. There are generally 2 notosetae and 2-3 acicula per notosetal fascicle in *M. australiensis;* there are one notoseta and 3-4 acicula in *M. pege. M. australiensis* has 3-4 neuroacicula per neuropodium; *M. pege* has 1-2.

The segment from which setal fascicles begin is variable in both *M. australiensis* and *M. clavicornis*. Neurosetae generally begin from segment 4 in the former species, and have been found in segment 3. The notosetae of *M. clavicornis* can begin from setigers 1, 2 or 3. The significance of this variability is not known, and these characters must be given little emphasis (Banse, 1969).

M. australiensis and *M. papillosa* are similar because the palpi are very close together, cushion-like elevations are present on the anterolateral lips of the mouth and conspicuous interramal papillae are present. Segments 2 and 3 of *M. papillosa*, and segments 1 and 2 of *M. australiensis* are ventrally fused.

M. australiensis and *M. papillosa* appear to bridge a gap between *Acrocirrus* and *Macrochaeta* because the palpi are very close together, and cushion-like ridges are present on the anterior lips. In addition, *M. australiensis* has orderly rows of epidermal papillae, and thoracic neuropodial lobes. Transverse rows of epidermal papillae have previously been characteristic of *Acrocirrus* (i.e. *A. crassifilis* Moore, 1923). *M. australiensis* and *M. papillosa*, however, lack inferior neuropodial papillae. It might be possible to establish a new genus for *M. australiensis*, but I believe this should not be done until morphological variation in *Macrochaeta* spp. is understood, and more information on the biology of this family is available.

DISTRIBUTION: *M. australiensis* has been found in Victoria.

KEY TO SPECIES OF *Macrochaeta*
(modified from Banse, 1969, p. 2610)

1.	Three or more neurosetae per fascicle .... *M. polyonyx* Eliason, 1962	
—	Only one or two neurosetae per fascicle	2
2.	More than four pairs of branchiae present .... *M. sexoculata* (Webster & Benedict, 1887)	
—	Four pairs of branchiae present	3
3.	Abdominal neurosetae as simple falcigers .... *M. helgolandica* Friedrich, 1937	
—	Abdominal neurosetae as composite falcigers..........................	4
4.	Cushion-like elevations present on anterolateral lips of mouth	5
—	Cushion-like elevations absent from anterolateral lips of mouth.........	6
5.	Segment 1 not dorsally visible .... *M. australiensis* n. sp.	
—	Segments 1 and 2 not dorsally visible .... *M. papillosa* Ehlers, 1913	
6.	Segment 1 dorsally visible.................... *M. clavicornis* (Sars, 1835)	
—	Segment 1 not dorsally visible .... *M. pege* Banse, 1969	

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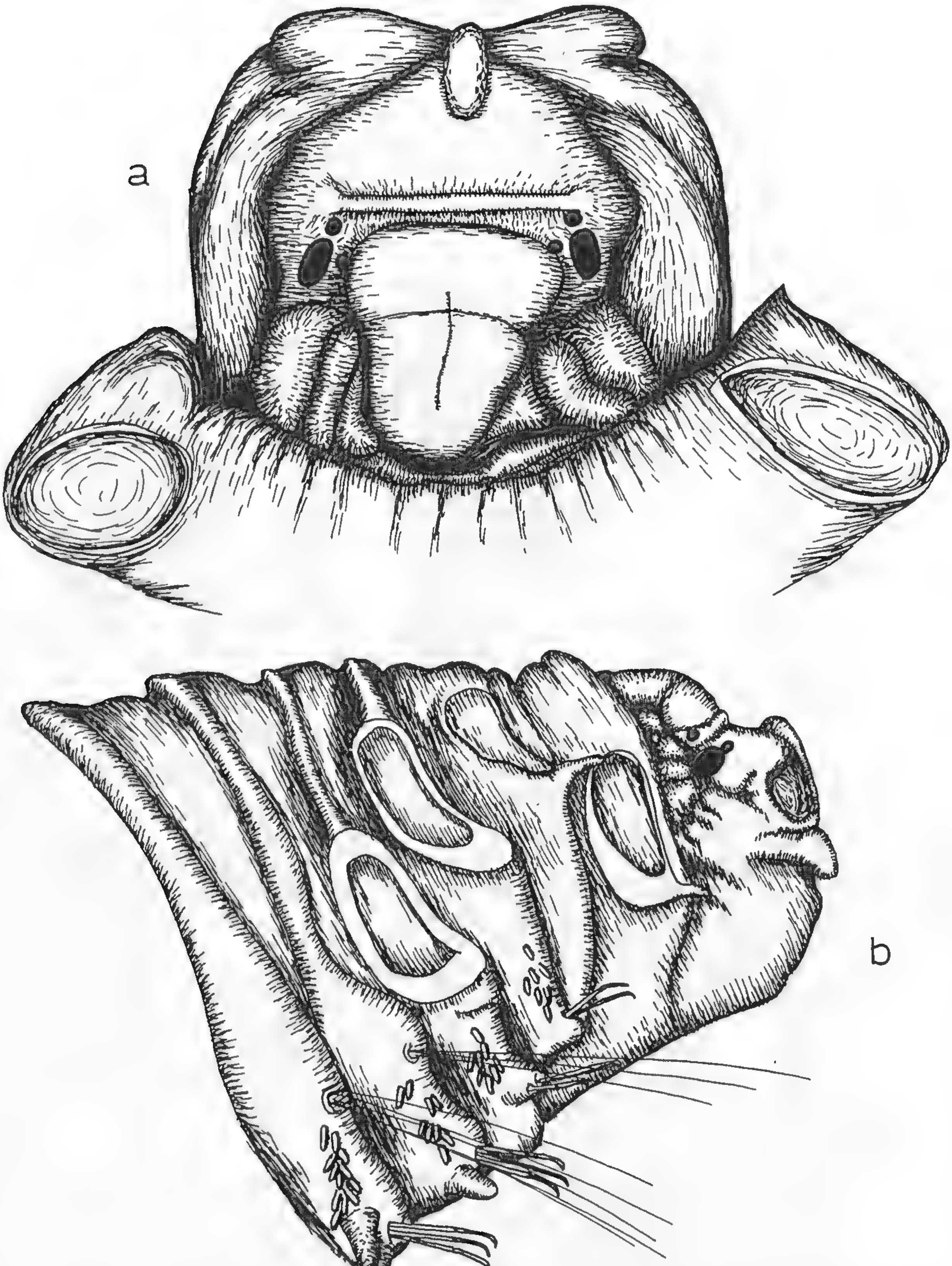

Fig. 1. *Acrocirrus aciculigerus* n. sp., Holotype. a, anterior segments, dorsal view, × 56; b, anterior segments, right lateral view, × 28.

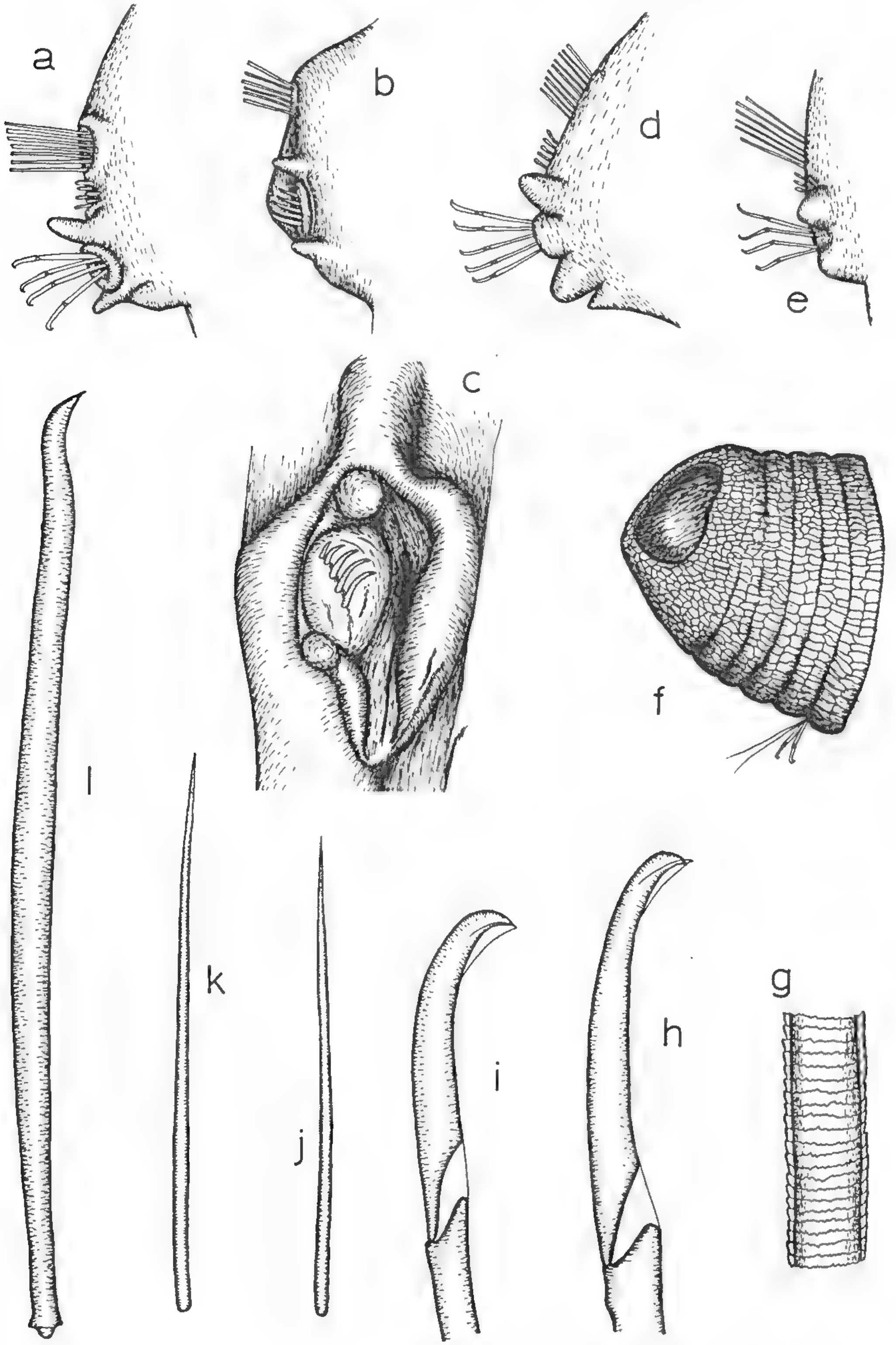

Fig. 2. *Acrocirrus aciculigerus* n. sp., Holotype, a right parapodium of segment 9, anterior view, × 19; b, right parapodium of segment 14, posterior view, × 19; c, right neuropodium of segment 14, ventrolateral view, × 38; d, right parapodium of segment 50, anterior view, × 19; e, right parapodium of segment 100, anterior view, × 19; f, pygidium of Paratype, right posterolateral view, × 38; g, distal region of notoseta, dorsal view, × 3065; h, thoracic neuroseta, lateral view, × 184; i, abdominal neuroseta, lateral view, × 184; j, notoaciculum, lateral view, × 121; k, neuroaciculum, lateral view, × 121; l, entire acicular hook from segment 14, lateral view, × 121.

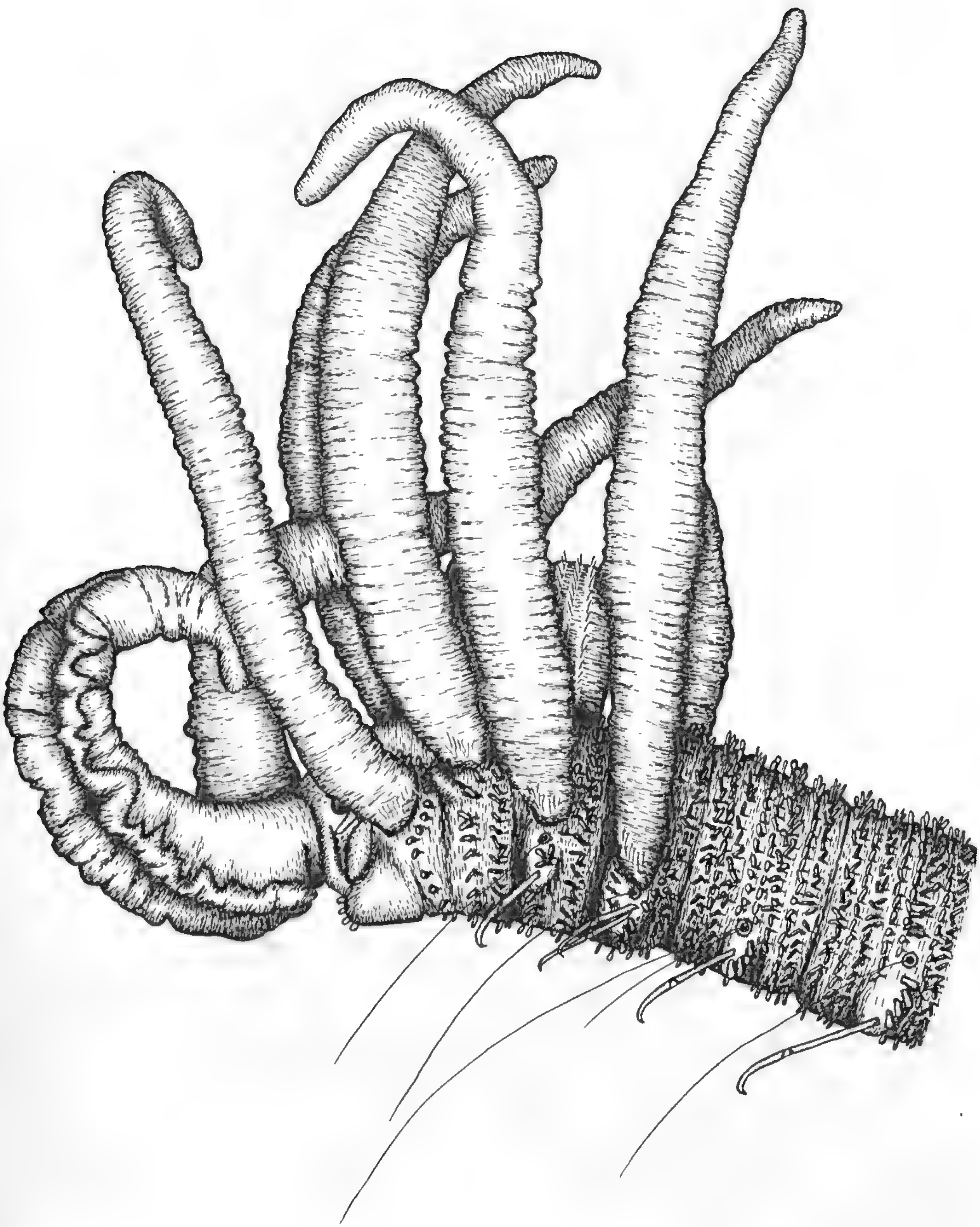

Fig. 3. *Macrochaeta australiensis* n. sp., Holotype. Anterior segments with intact palpi and branchiae, left lateral view, × 60.

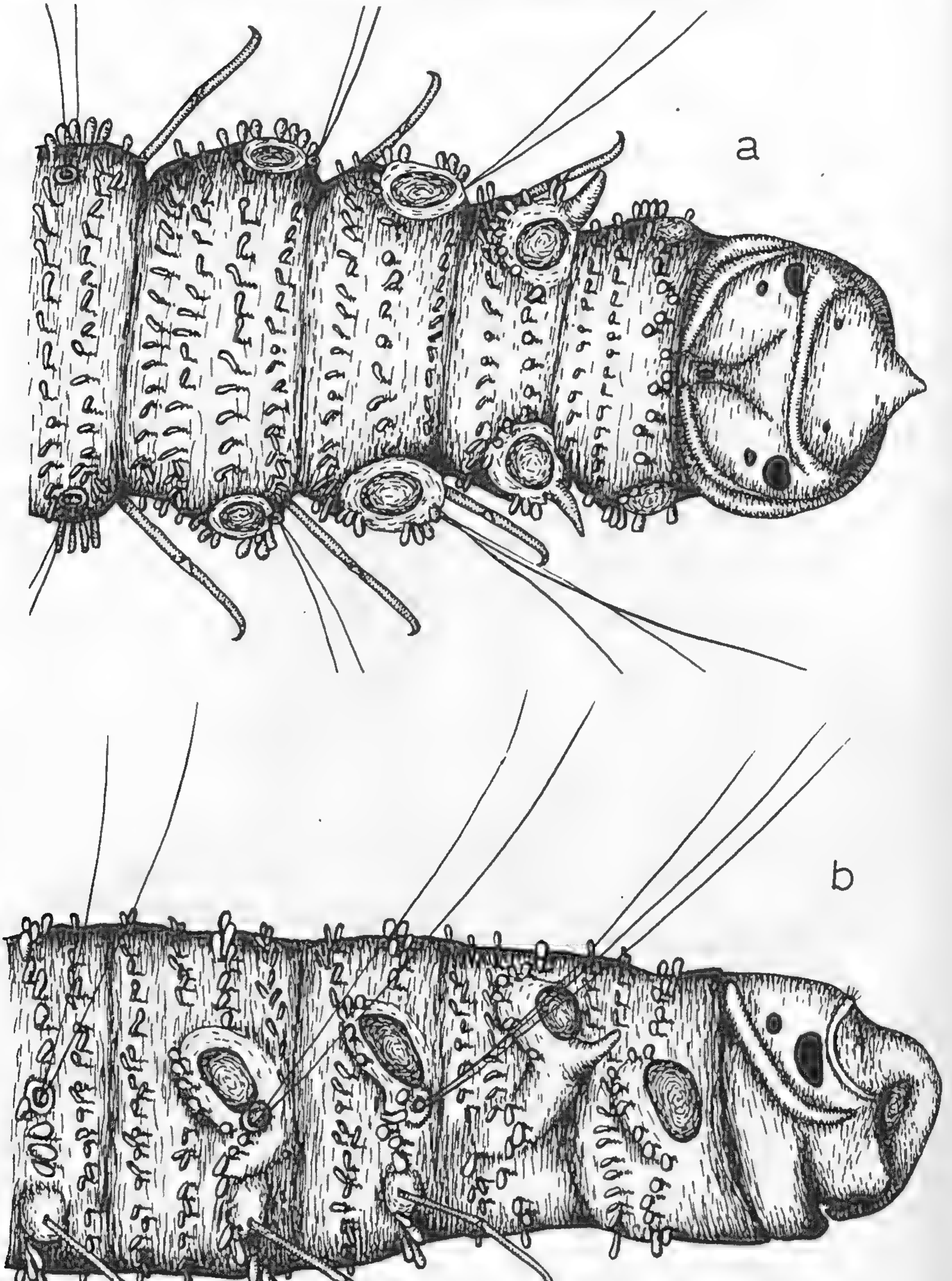

Fig. 4. *Macrochaeta australiensis* n. sp., Paratype. a, anterior segments, dorsal view, × 94; b, anterior segments, right lateral view, × 94 (branchial scars indicate positions of detached branchiae).

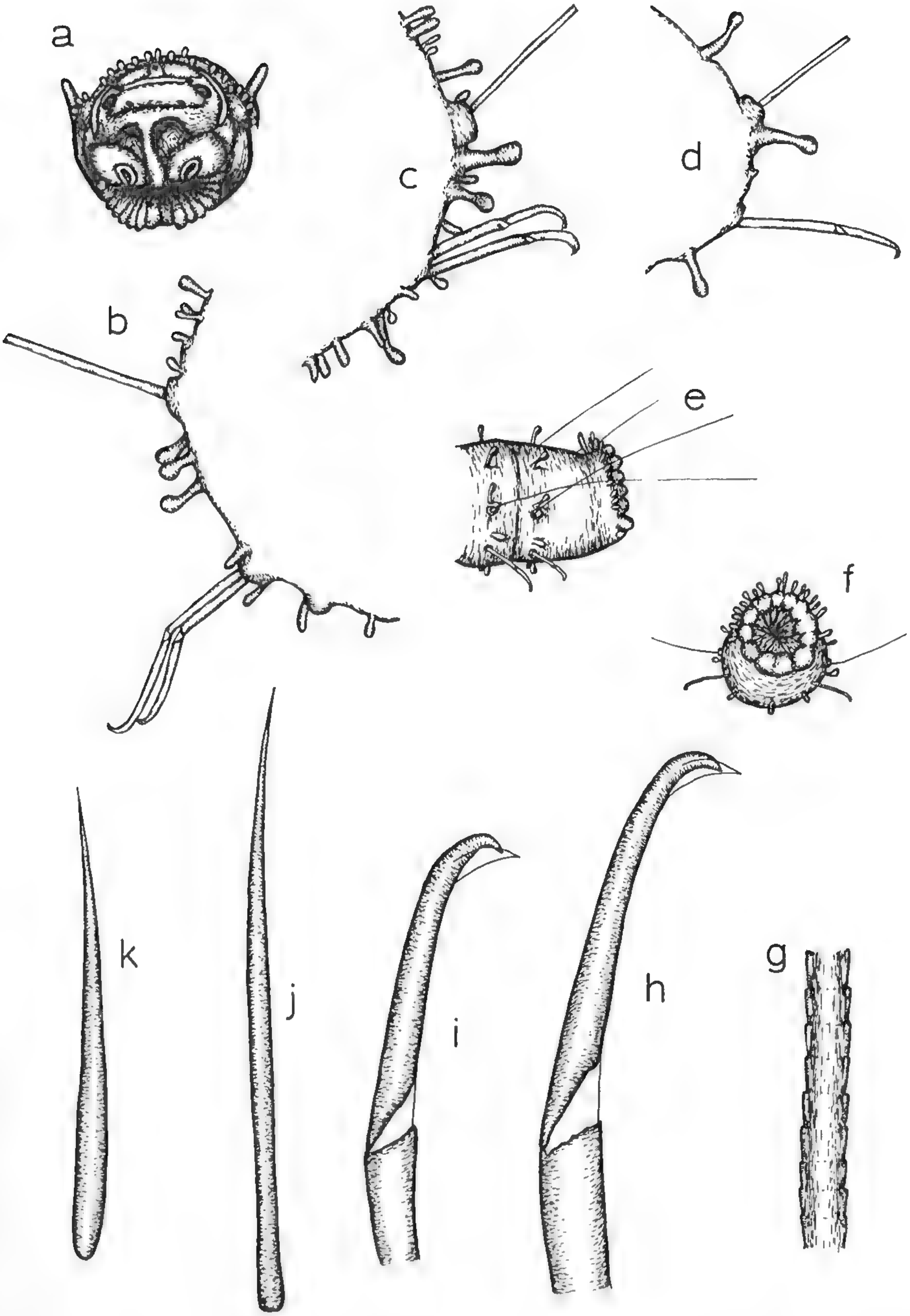

Fig. 5. *Macrochaeta australiensis* n. sp., Paratype. a, prostomium and mouth, anterior frontal view, × 63; Holotype. b, right parapodium of segment 12, anterior view, × 179; c, left parapodium of segment 22, anterior view, × 179; d, left parapodium of segment 41, anterior view, × 179; e, pygidium, left lateral view, × 63; f, pygidium, posterofrontal view, × 63; g, distal region of notoseta, dorsal view, × 3417; h, thoracic neuroseta, lateral view, × 452; i, abdominal neuroseta, lateral view, × 452; j, notoaciculum, lateral view, × 452; k, neuroaciculum, lateral view, × 452.

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(viii) References (see below).

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The approximate position of tables and figures should be indicated in pencil at the left-hand margin.

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A REVISION OF THE AUSTRALIAN AND TROPICAL INDO-PACIFIC TERTIARY AND RECENT SPECIES OF *PISINNA* (=*ESTEA*) (MOLLUSCA: GASTROPODA: RISSOIDAE)

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SUMMARY

The Recent and Tertiary species of *Pisinna* Monterosato (=*Estea* Iredale) from Australia and the tropical Indo-Pacific are reviewed. 26 species are recognised from temperate Australia and 11 from tropical Australia and the Indo-Pacific. The extralimital species, with the exception of those from New Zealand, are also briefly reviewed. 10 new species and 2 new subspecies are described and radulae and opercula of some species are illustrated.

CONTENTS

INTRODUCTION

The genus *Pisinna* Monterosato (=*Estea* Iredale) is richly represented in temperate Australasia, where many species live in the lower intertidal zone and on the continental shelf.

The first species described from Australia were collected by the *Novara* Expedition in the Sydney area in 1858 and the results were published by Frauenfeld in 1867. Early Tasmanian workers such as J. E. Tenison Woods, W. F. Petterd and W. L. May described several species. A few additional species were added by C. Hedley, J. H. Gatliff, C. J. Gabriel, and B. C. Cotton. The most important recent revision was that of C. F. Laseron (1950) when he revised the New South Wales Rissoidae and described several new species. Worthy of record is the fact that an early amateur conchologist, Mr. A. U. Henn, had recognised several

Records of the Australian Museum, 1976, **30**, 150-247, Figures 1-20.

of Laseron's species as new and illustrated them (the drawings are now in the Western Australian Museum, and the figured specimen lots in the Australian Museum). Laseron later (1956), in a review of the northern Australian Rissoidae, described new species of *Estea* and *Scrobs*, some of which are here recognised as *Pisinna*.

Ponder (1965c) reviewed the Recent and Tertiary species of *Estea* in New Zealand, and later (1968b) added 3 new species and subspecies. The genus is one of the most diverse of the family Rissoidae in temperate Australasia, there being 23 Recent species and subspecies known from New Zealand and 28 from temperate Australia. Tropical species are fewer, only 7 Recent species being known from tropical Australia, one of these (*tropica* Laseron) being distributed widely in the south west Pacific.

The familial and subfamilial location of the genus (as *Estea)* has been discussed by Ponder (1967).

BIOLOGY AND ANATOMY: Ponder (1968a) has described the anatomy of two New Zealand species, and earlier (1965c), the external features of several species. Risbec (1942) described the gross anatomy of "*Barleia rosea* Hutton" (=*Pisinna* sp.) from New Caledonia. *Pisinna* species are probably diatom scrapers (micro-herbivores) but no positive information is available and nothing is known of their life histories.

The two species examined by Ponder (1968a) were *P. semiplicata* (Powell) and *P. zosterophila* (Webster). These species are probably typical of the genus *Pisinna* in the main features of their anatomy. The head bears a pair of setose, club-shaped cephalic tentacles, and a broad bilobed snout, the foot has a large, internally massive posterior pedal gland which opens into a median slit in the posterior half of the ciliated sole. There are no accessory tentacles and the propodium is very indistinct, the anterior pedal gland being poorly developed. Most species and genera of the Anabathroninae have a similar external appearance except that the smaller genera tend to lose the posterior mucous slit in the sole.

The mantle cavity is like that of most small prosobranchs in having a long osphradium and a row of finger shaped ctenidial filaments. The osphradium, however, of *Pisinna* and other Anabathroninae is bordered by glandular, not ciliated ridges, and thus they differ from most other rissoaceans. The alimentary canal is unusual in that there is both an oesophageal gland and a crystalline style present. There are no jaws and the salivary glands are a pair of simple tubes. The other members of the Anabathroninae that have been examined (Ponder, 1968a) have a similar alimentary canal. The other subfamilies of the Rissoidae differ from the Anabathroninae in not having an oesophageal gland.

The reproductive system is fairly typical of the family Rissoidae. The penis of *Pisinna* and other Anabathroninae is unusual in being attached mid-dorsally behind the head instead of on the right side of the head, as it is in most other rissoaceans.

The female reproductive system has been examined only in *P. semiplicata* which has large yolky eggs in the ovary. The upper oviduct is a simple, narrow tube which expands to form a glandular pouch at its junction with the seminal receptacle and the duct of the albumen gland. Another duct leads to a muscular tube which terminates blindly as a muscular bulb (?bursa copulatrix) in one direction and in the other it narrows to connect with the ventral channel of the capsule gland. The only other species of the Anabathroninae whose reproductive system has been described is *Scrobs hedleyi* (Suter) (Ponder, 1968a) which shows a similar arrangement of organs and a bursa copulatrix occupies the position of the blind muscular bulb of *P. semiplicata*. This muscular bulb was not observed to store sperm and consequently its function is in doubt.

HABITAT: Many species of *Pisinna* live on algae in the lower littoral zone, and in the sublittoral, whereas others prefer the under surface of rock or coral blocks. Often the same

species are found in a variety of microhabitats (e.g. pools, exposed rock faces) on varying substrates (e.g. under stones, on algae) in the one geographic location. Species found on the continental shelf supposedly on soft substrate are probably occupying small patches of hard substrate (such as accumulations of dead shell) rather than moving about on the soft sediments.

GEOLOGICAL HISTORY: The genus first appears in the Duntroonian (Middle Oligocene) of New Zealand and there are 8 species known only as fossils although one Recent species *olivacea*, subspecies *impressa* (Hutton, 1885), extends back to the Duntroonian. Only one extinct Australian fossil subspecies is here recognised which is known from the Lower Miocene. However the number of available samples is not great and undoubtedly additional species will be located. *Pisinna bikiniensis* (Ladd) from the Lower Miocene of Bikini Atoll, Marshall Islands is the only known fossil species in the tropical Indo-Pacific. Unfortunately no material has been available for checking fossil occurrences in the Mediterranean area, although a probable Miocene species has been named (see under *P. punctulum* (Philippi) below).

Thus, from the rather flimsy evidence it could be suggested that the genus had its origins in the temperate Australian area (probably New Zealand) and then spread widely through the Indo-Pacific and to the Mediterranean via the Tethys Sea. It is, however, also possible that *Pisinna* evolved in the early Tertiary Tethys Sea and then migrated southwards followed by a spectacular speciation in the temperate waters of Australasia.

TECHNIQUES

Material was obtained from several types of sample which were hand-sorted beneath a low-power binocular microscope. The samples included debris washed from littoral and sublittoral algae (algae washings), debris washed from beneath littoral or sublittoral stones, rocks or coral blocks (stone (etc.) washings) and benthos samples obtained by dredging. These samples were usually fixed in 10% neutral formaldehyde.

The specimens obtained were generally split into two fractions, one fraction being preserved in 5% neutral formaldehyde and the other dried.

Radulae were mounted after dissolving the animal tissue in NaOH, washing in distilled water and drying on a fragment of a microscope-slide coverslip. The mount was coated with gold and examined with the scanning electron microscope (SEM). Opercula were simply removed from the animal, washed in distilled water, and mounted for examination with the SEM.

All shell drawings were done by using a "Wild" M5 microscope and drawing apparatus.

AVAILABILITY OF MATERIAL

Much of the material examined, apart from that already housed in museums, was sorted from samples during the course of this study. Samples have been made available from several sources and as a result the southern, south-eastern and northern continental shelves of Australia have been moderately well covered. The western shelf has been barely sampled for micro-Mollusca, although several small samples have been available from the N.W. Australian shelf. Little material was available from the Torres Strait region although "Chevert" and "Challenger" stations were made in this area and one species (*Pisinna eurychades* (Watson)) was described from the latter expedition.

Good series of littoral and shallow sublittoral samples have been available from parts of most states, except South Australia and Northern Territory. In addition, some littoral and shallow sublittoral material has been examined from New Caledonia, Fiji, Solomon Islands, the New Hebrides and Papua-New Guinea.

Extensive shallow and deep water Philippines, and central Pacific shallow water collections in the U.S. National Museum failed to reveal any species of *Pisinna*, and the Hawaiian collections in the U.S. National Museum and Bishop Museum, Honolulu, also failed to reveal additional species. A small amount of material from Japan and Hong Kong has been examined, but again, no additional species have been found. One species is named from Mauritius (*microthyra* (Martens)), one species (*cazini* (Velain)) was described from the Island of St. Paul, southern Indian Ocean, and one species (*kis* (Winckworth)) is named from Ceylon. What is here believed to be a single species (*punctulum* (Phillipi)), is known from the Mediterranean Sea and one (*crawfordi*, (Smith)) is known from South Africa.

Despite searching collections in many overseas museums, no species referable to *Pisinna* has been found from west Africa, the Red Sea — Persian Gulf nor the whole Atlantic — Caribbean area.

A small collection of Australian fossil material has been available for study but this, for the most part has been inadequate for a proper understanding of the taxonomy of the fossil species.

ABBREVIATIONS

A.M. .... the Australian Museum, Sydney.
B.M.N.H. .... British Museum (Natural History), London.
B.M.R. .... Bureau of Mineral Resources, Canberra.
coll. .... collected by.
Coll. .... collection.
N.M.V. .... National Museum of Victoria, Melbourne.
N.S.W. .... New South Wales.
Qld .... Queensland.
S.A. .... South Australia.
S.A.M. .... South Australian Museum, Adelaide.
Tasm. .... Tasmania.
T.M. .... Tasmanian Museum, Hobart.
Vic. .... Victoria.
W.A. .... Western Australia.
W.A.M. .... Western Australian Museum, Perth.

Note: In the locality data, and sometimes elsewhere, compass points (north, south etc.) are abbreviated to N., S. etc.

TAXONOMY

Family Rissoidae
Subfamily Anabathroninae
Genus *Pisinna* Monterosato, 1878: 86.
Type species: (S.D. Cossmann, 1921: 33) *Rissoa punctulum* Philippi, 1836: 154.
Synonyms: *Estea* Iredale, 1915: 451.
Type species (o.d.) *Rissoa zosterophila* Webster, 1898.
Nodulestea Iredale, 1955: 81.
Type species (o.d.) *Estea castella* Laseron, 1950.
Feldestea Iredale, 1955: 81.
Type species (o.d.) *Rissoa salebrosa* (Frauenfeld, 1867) (=*Alvania salebrosa* Frauenfeld).
Microestea Ponder, 1965c: 156.
Type species (o.d.) *Estea angustata* Powell, 1927.

DESIGNATION OF TYPE SPECIES: Varying interpretations have been placed on the type designation of this genus. The first valid designation appears to be that of Cossmann (1921: 33), but Wenz (1938: 612), Ludbrook (1956: 26) and Ladd (1966: 62) list the type designation as 'monotypy'. When Monterosato introduced *Pisinna* he listed two species, "*Rissoa glabrata* auct" (non v. Mülhfeldt, 1824) = *R. punctulum* Philippi (with two synonyms) and *Rissoa seminulum* Monterosato, 1877. Examination of Monterosato's type material suggests that *seminulum* is not a *Pisinna* and probably belongs near *Barleeia* Clark.

NOTE ON SYNONYMY: Thiele (1929: 162), Wenz (1938: 612), Ludbrook (1956: 26) and Macpherson and Gabriel (1962: 91) correctly regard *Estea* as a synonym of *Pisinna* whereas New Zealand workers and most other Australian workers have used *Estea*. Examination of the type species of *Pisinna* has confirmed that *Estea* and *Pisinna* cannot be separated on shell, radular or opercular characters. The authors have not been able to locate a description of the external features of the animal of *P. punctulum*.

Nodulestea and *Feldestea* were erected for sculptural forms of *Pisinna*. All gradation between smooth, axially ribbed and spirally keeled species occur in the genus and to separate any one of these groups would create an artificial assortment of species sharing only superficial sculptural features. *Microestea* was separated because of its smaller, thinner shell from typical *Estea* (i.e. *Pisinna*) but its recognition seems to be unnecessary in view of the range of size seen in the genus as a whole.

TERMINOLOGY: The descriptive terminology employed for gastropod shells has never been completely stabilised. Recent reviews by Cox (1955, 1960) have put forward non-ambiguous terms for use in directional description, and because these terms are likely to gain general acceptance and are less ambiguous than other terminology, they are employed here (see figure 1).

The descriptive terminology used for the radula and operculum follows Ponder (1965a).

DIAGNOSIS: Shell — Small, more-or-less pupiform, dull or glossy; spire longer than aperture, outline straight to moderately convex. *Protoconch* dome-shaped, usually reddish, 1½ to 2 whorls, surface minutely pitted, the pits usually in close spiral rows. *Teleoconch* with aperture typically almost circular to obliquely oval, slightly angled adapically, peristome continuous, usually thickened within, outer lip sharp-edged. Inner lip distinct, fixed to parietal area in adapical portion, free or partially free in abapical region (i.e. separated from base to some extent). Surface smooth or sculptured with axial ribs or, more rarely, spiral grooves or cords. Umbilicus absent. A distinct, chitinous internal shell layer present (Fig. 12 c-d).

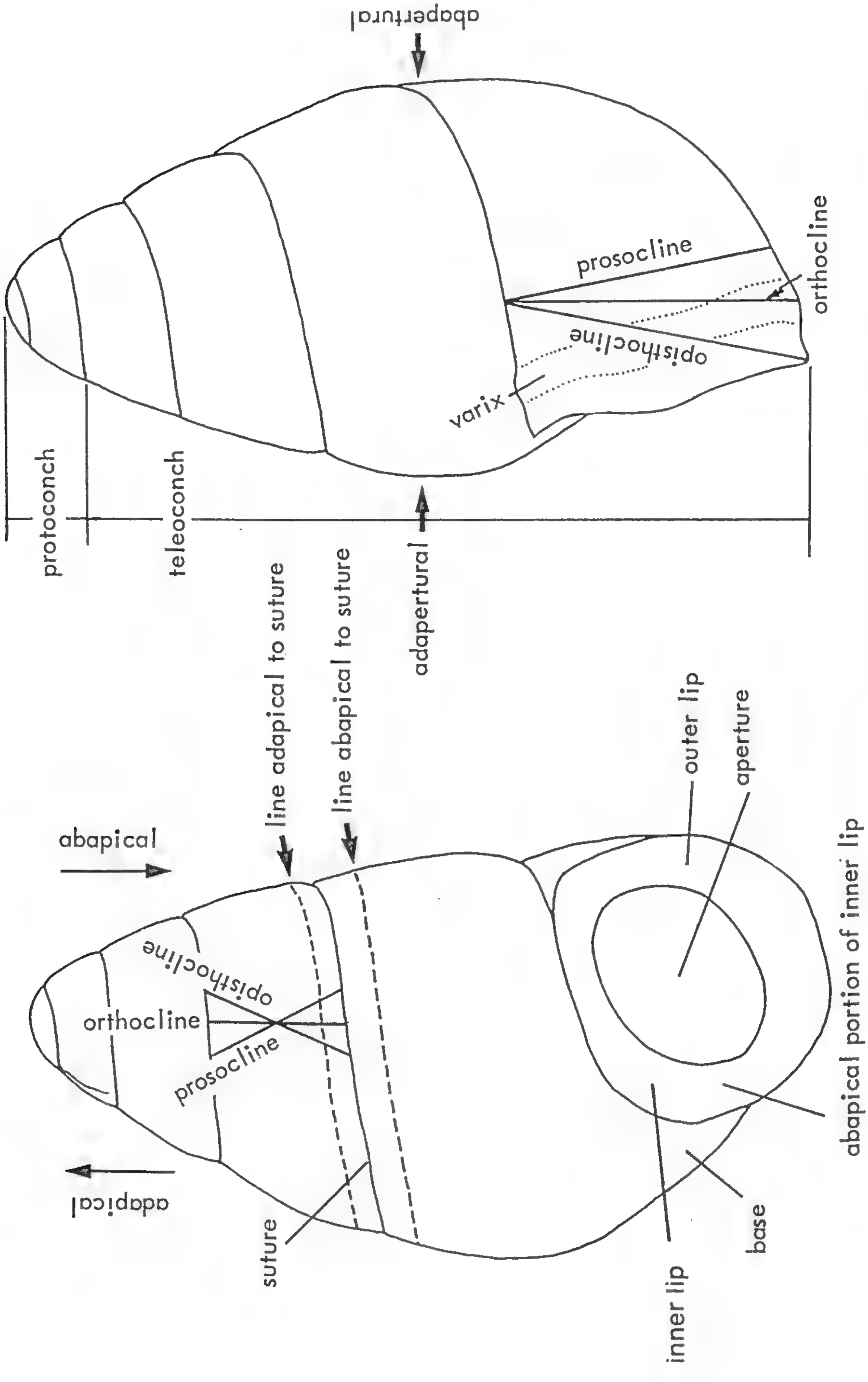


Figure 1. Diagrammatic views of a generalised Pisinna shell to illustrate the descriptive terminology employed.

Operculum — Thin, transparent, colourless or pale yellow; oval, nearly flat, nucleus small, indistinct. Marginal areas usually narrow. Muscle insertion area typically distinct, occupying columellar half and up to 2/3 of surface, slightly thickened. Composed of 2 separable layers (Fig. 13b-c).

Head Foot — Cephalic tentacles club shaped, with stationary cilia terminally and a tract of posteriorly directed cilia on ventral surface. Eyes in bulges at outer bases of tentacles. Snout rather large, bilobed, mobile. Foot moderately long, a distinct groove on anterior edge, posterior mucous gland with a slit in posterior half of sole. Opercular lobes simple. No accessory tentacles. Penis coiled, simple, attached to midline some distance behind head.

Radula — Central teeth relatively large, each with a pair of long basal processes and usually a pair of accessory denticles beside each process; cusps 1-3+1+3-1, the middle cusp longest. Lateral teeth rather small, with a long, narrow outer, oblique limb and shorter vertical limb beneath main cusp; cusps large, 2-3+1+2-5. Marginal teeth elongate, approximately parallel-sided, curved distally, denticulate, outer marginal more finely denticulate than inner.

SPECIES RECENTLY REFERRED TO *PISINNA* OR *ESTEA* BUT NOT INCLUDED IN *PISINNA* IN THE PRESENT REVISION.

Generic and family locations are suggested following each name.

alvea Laseron, 1950. Cingulopsidae. Note 2.

amblycorymba Cotton, 1944. *Nozeba* (Rissoidae).

aurantiocincta May, 1915. *Crassitoniella.* (Eatoniellidae). Note 3.

chrysalida Chapman & Gabriel, 1914. *Botelloides* (Rissoidae).

erma Cotton, 1944. *Notoscrobs (Microfossa)* (Rissoidae).

erratica May, 1912. *Crassitoniella* (Eatoniellidae). Note 3.

figula Laseron, 1950. *Peringiella* s.l. (Rissoidae). Note 5.

flammea Frauenfeld, 1867. *Crassitoniella* (Eatoniellidae). Note 3.

gregaria Laseron, 1950. Cingulopsidae. Note 2.

incidata Frauenfeld, 1867. *Notoscrobs (Microfossa)* (Rissoidae). Note 4.

iravadioides Gatliff & Gabriel, 1913. *Microdryas.* (Rissoidae). Note 4.

janjucensis Gatliff & Gabriel, 1913. *Microdryas* (Rissoidae). Note 4.

labrotoma May, 1919. *Notoscrobs (Microfossa)* (Rissoidae).

lunata Laseron, 1956. Genus? Cingulopsidae.

obeliscus May, 1915. Genus? Rastodentidae? Note 8.

perpolita May, 1919. *Powellisetia* s.l. (Rissoidae). Note 6.

pertumida May, 1915. *Powellisetia* s.l. (Rissoidae). Note 6.

praeda Hedley, 1908. *Rissoa (Haurakia)* (Rissoidae).

puer May, 1921 (nom. nov. pro *Rissoa pupoides* May, 1915). Genus? Rastodentidae? Note 8.

pulvilla Hedley, 1906. *Peringiella* s.l. (Rissoidae). Note 5.

pyramidata Hedley, 1903. *Pseudestea* (Rissoidae).

rubicunda Tate & May, 1900. *Peringiella* s.l. (Rissoidae). Note 5.

subbicolor Ludbrook, 1956. *Crassitoniella* (Eatoniellidae). Note 3.

tiara May, 1915. *Powellisetia* s.l. (Rissoidae). Note 6.

xanthias Watson, 1886. Genus? (Rissoidae). Note 7.

TAXONOMIC NOTES ON SPECIES WRONGLY LOCATED IN *PISINNA*.

NOTE 1: Cotton (1944: 292) introduced *Subestea* for 3 species: *seminodosa* May, 1915 (as the type of the genus), *salebrosa* Frauenfeld, and *flindersi* T. Woods. The latter two species are typical *Pisinna* but *seminodosa* is closely related to *Merelina* Iredale, 1915.

NOTE 2: Several minute species closely resembling *Pisinna* in teleoconch characters are known from Australian and Pacific waters. Laseron (1950) described two New South Wales species as *Estea*, *E. gregaria* and *E. alvea*, but most of the other species are undescribed. The protoconch of these minute species is smooth and the radular, opercular and head-foot characters place them in the Cingulopsidae (see Ponder, 1965b). They probably require a new generic name which will be provided in a forthcoming revision of the Australian species of that family.

NOTE 3: The species listed as Eatoniellidae are to be the subject of a future revision where more definitive generic and subgeneric placements will be made.

The original material of the fossil species *subbicolor* Ludbrook, consists of a mixture of three species, the most abundant being *Notoscrobs (Microfossa)* cf *erma* (Cotton). The holotype, however, is a *Crassitoniella*.

NOTE 4: The genus *Microdryas* Laseron, 1950, was based on a misidentified type species. This is the subject of a submission currently placed before the International Commission on Zoölogical Nomenclature.

NOTE 5: The systematic position of the species listed as belonging to *Peringiella* s.l. is problematic in that the genus *Peringiella* needs to be clarified. The three names included here appear to represent only one species, *rubicunda* Tate and May.

NOTE 6: The several species listed as *Powellisetia* Ponder, 1967 are only tentatively placed there as only the shells are available for examination.

NOTE 7: *Mucronalia xanthias* Watson was transferred to *Estea* by Laseron (1956) but differs considerably in having a narrow, several-whorled protoconch and a differently sculptured teleoconch. The relationships of this species are obscure, but possibly lie with *Scaliola* rather than the Rissoidae.

NOTE 8: The two species *obeliscus* May and *puer* May are possibly representatives of the Rastodentidae (Ponder, 1966) but only shells have been examined and definite placement in this family must await at least the examination of the radulae and opercula of these species.

SPECIES TAXONOMY

The following descriptive section dealing with the species of *Pisinna* is divided into the following parts:

1. The Tertiary and Recent temperate Australian species.

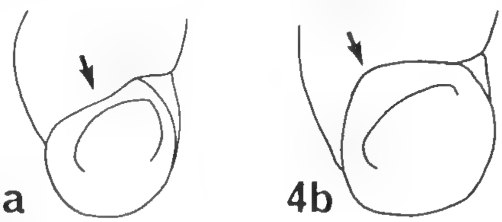
2. The Tertiary and Recent tropical species comprising those Australian species whose distribution is centred north of Moreton Bay on the east coast of Australia, and N.W. Cape on the west coast. It also includes the other species from the tropical Pacific not occurring in Australia.

3. The extralimital species. A brief synopsis of those species occurring in the temperate Indian Ocean and the Mediterranean Sea.

All species are listed in alphabetical order.

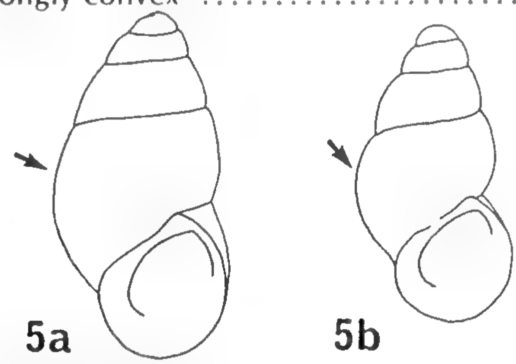
KEY TO THE RECENT TEMPERATE AUSTRALIAN SPECIES

1.	a. Teleoconch without axial ribs	2
	b. Teleoconch with axial ribs	20
2.	a. Shell less than 3 mm in length	3
	b. Shell greater than 3 mm in length	14
3.	a. Spire short (up to 1½ × length of aperture)	4
	b. Spire medium to long (greater than 1¾ × length of aperture)	6
4.	a. Shell brown with more or less straight or slightly concave edge to inner lip	5
	b. Shell pinkish with strongly convex edge to inner lip	*circumlabra* nov.



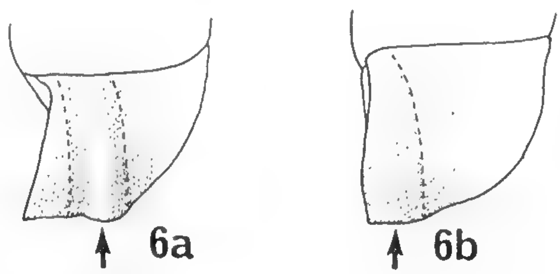
4a 4b

5.	a. Whorls weakly convex	*dubitabilis* (Tate)
	b. Whorls strongly convex	*megastoma* nov.



5a 5b

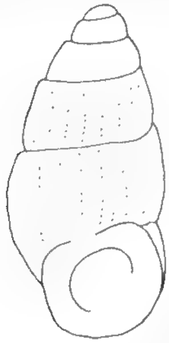
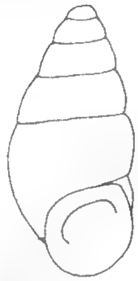
6.	a. With very strong varix	*laseroni* nov.
	b. With weak varix or none	7



6a 6b

7.	a. Shell 2 mm-3 mm in length	8
	b. Shell less than 2 mm in length	11

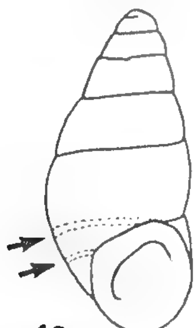
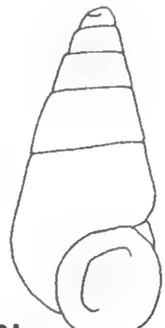
8. a. Shell very solid, whorls convex, usually sutures deeply impressed, colour mostly greyish, typically with fine axial riblets .... *varicifera relata* (Cotton)
b. Shell moderately solid, whorls weakly convex, sutures not deeply impressed, colour pinkish or brown 9

8a 8b

9. a. Brown with whitish band abapical to sutures (sometimes rather strong axial ribs on body whorl) .... *albizona* (Laseron)
b. Uniform brown or pinkish, sometimes with darker bands 10

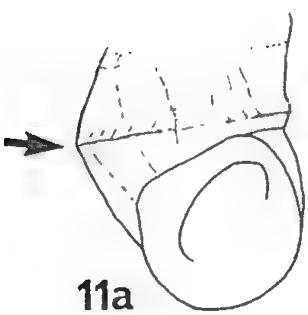
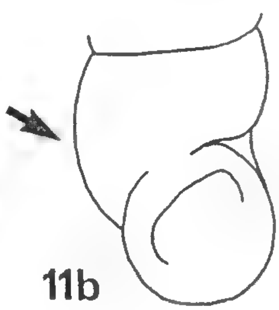
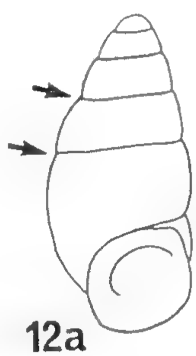
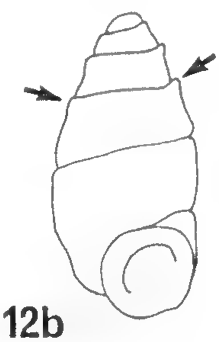
10. a. Brown to yellowish sometimes with 2 brown bands on body whorl, spire outline slightly convex (never strongly axially ribbed) .... *frenchiensis* (Gatliff & Gabriel)
b. Pinkish to yellowish, spire with straight outlines (sometimes axially ribbed on body whorl) .... *tasmanica* (T. Woods)

10a 10b

11. a. Body whorl subangled to strongly keeled at periphery and sometimes spirally ribbed abapical to sutures .... *vincula* (Laseron)
b. Body whorl rounded 12

12. a. Sutures simple 13
b. Sutures stepped .... *gradata* nov.

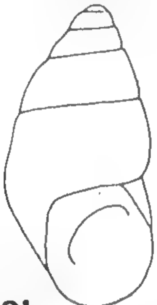





11a 11b 12a 12b

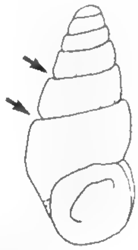
13. a. Aperture with narrow, thin inner lip, shell rather thin, narrowly pupoid, whorls often distinctly convex .... *approxima* (Petterd)
b. Aperture with wide, thickened inner lip, shell solid, conical, whorls almost flat .... *circumlabra* nov.

14. a. Sutures deeply indented (usually with fine axial riblets) .... *varicifera relata* (Cotton)
b. Sutures not deeply indented 15

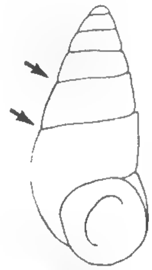
13a



13b

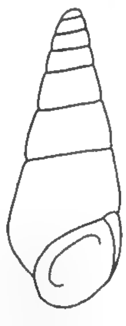


14a

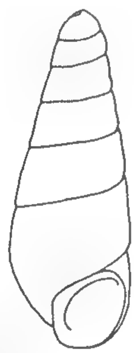


14b

15. a. Spire of medium length (2-2½×length of aperture) 16
b. Spire tall (about 3×length of aperture) .... *voorwindei* nov.



15a



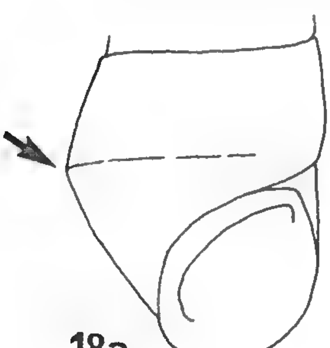
15b

16. a. Pale colour band adapical to sutures or uniform in colour 17
b. Blotchy colour pattern .... *moretonensis* nov.

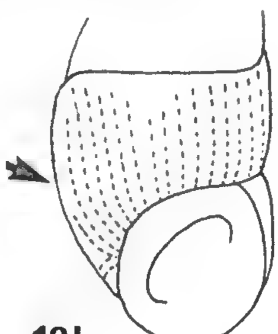
17. a. Teleoconch completely smooth 18
b. Teleoconch with indistinct axial rugae .... *paucirugosa* nov.

18. a. Periphery subangled .... *nitida* nov.
b. Periphery evenly convex .... *bicolor* (Petterd)

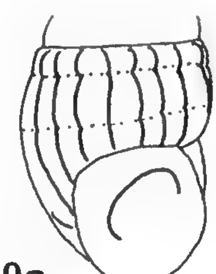
19. a. Axial ribs strong and broad 20
b. Axial ribs weak and threadlike 29



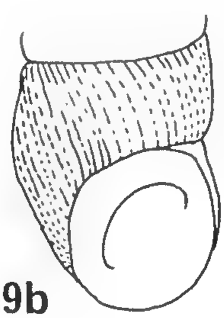
18a



18b

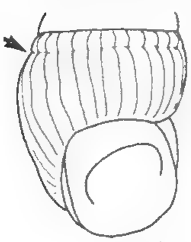
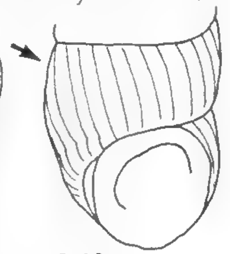


19a

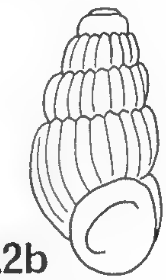


19b

20. a. Axials over whole surface of teleoconch 21
b. Axials restricted to last two whorls 27
21. a. Row of nodules present abapical to sutures 24
b. No row of nodules present 22
22. a. Shell inflated, larger than 3 mm .... *frauenfeldi* (Frauenfeld)
b. Shell narrowly conical, about 3 mm or less 23

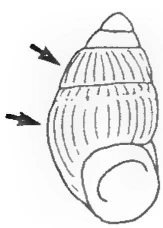



21a 21b

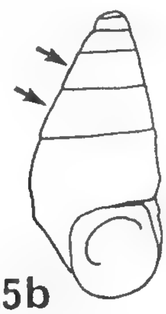



22a 22b

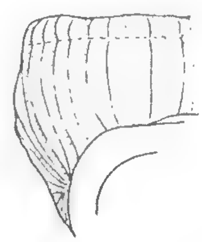
23. a. Axials rounded and about equal in width to interspaces .... *kershawi* (T. Woods)
b. Axials flat with very narrow interspaces .... *costata* (Hedley)
24. a. Axials broken into 3 rows of nodules by spiral grooves .... *castella* (Laseron)
b. Axials simple below row of nodules immediately abapical to sutures . 25
25. a. Spire outlines convex, axials often weak on first 2 whorls .... *olivacea olivacea* (Frauenfeld)
b. Spire outlines more or less straight 26
26. a. Axials simple, straight, of uniform size .... *tumida* (T. Woods)
b. Axials irregular in shape, alternating large and small .. *flindersii* (T. Woods)



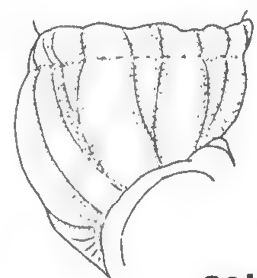
25a



25b

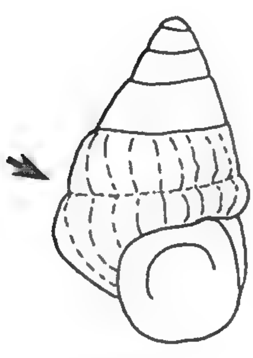


26a

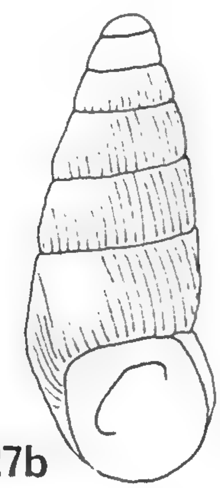


26b

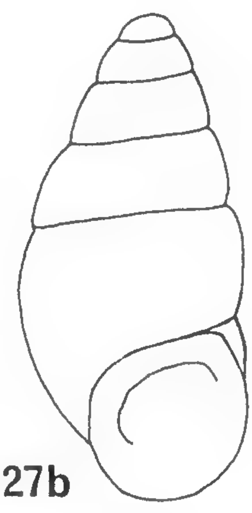
27. a. Shell inflated, with spiral depression in middle of body whorl .... *salebrosa* (Frauenfeld)
b. Shell narrowly conical 28



27a

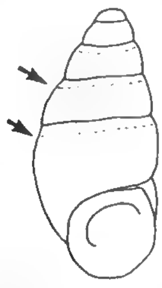


27b

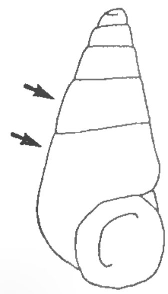


27b

28. a. Outline of spire lightly convex, (sometimes smooth) with pale band abapical to sutures .... *albizona* (Laseron)
b. Outline of spire straight with no bands (sometimes smooth) .... *tasmanica* (T. Woods)

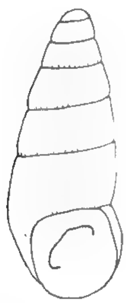


28a

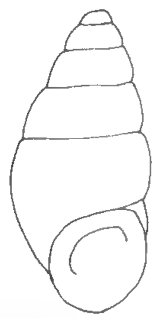


28b

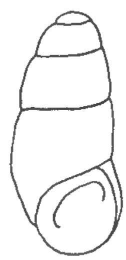
29. a. Shell elongate .... *columnaria* (Hedley)
b. Shell not elongate 30



29a

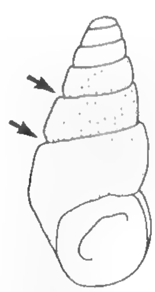


29b

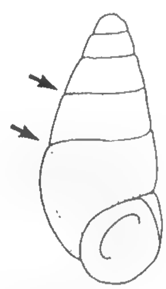


29b

30. a. Shell more than 2.8 mm in length 31
b. Shell less than 2.8 mm in length .... *oblata* (Laseron)
31. a. Sutures deeply indented .... *varicifera relata* (Cotton)
b. Sutures not deeply indented .... *paucirugosa* nov.



31a

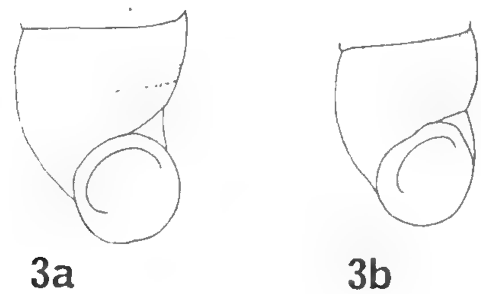


31b

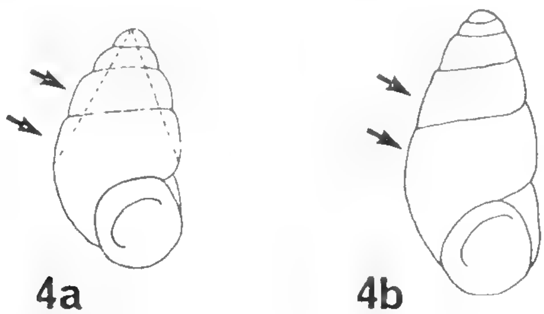
KEY TO THE RECENT TROPICAL AUSTRALIAN AND INDO-PACIFIC SPECIES

1. a. Teleoconch smooth 2
b. Teleoconch sculptured with axial ribs 6
2. a. Shell larger than 2 mm in length 3
b. Shell smaller than 2 mm in length 4

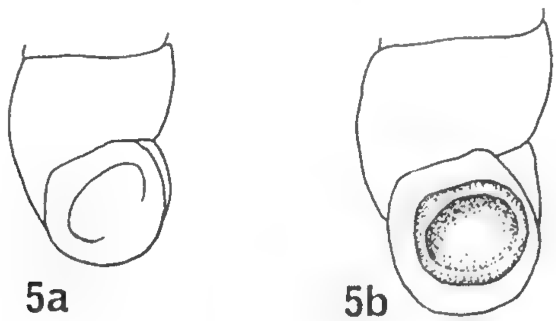
3. a. Shell about 2.2 mm in length, with pale central band, aperture strongly contracted .... *eurychades* (Watson)
b. Shell about 2.3 mm in length, with dark orange-brown axial lines, aperture barely contracted .... *perdigna* (Laseron)



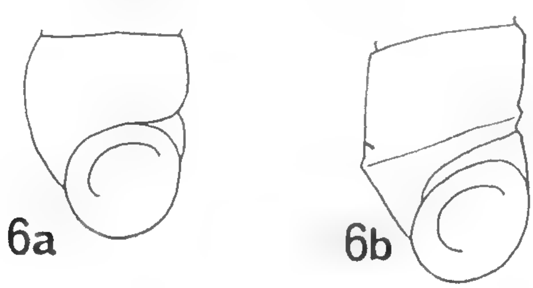
4. a. Spire outline convex 5
b. Spire outline straight ....*compressa* (Laseron)



5. a. Aperture simple .... *tropica* (Laseron)
b. Aperture with internal rim .... *incipiens* (Laseron)



6. a. Periphery rounded 7
b. Periphery sharply angled .... *angulata* nov.



7. a. Shell less than 2.5 mm in length 8
b. Shell greater than 2.5 mm in length .... *colmani* nov.
8. a. Shell with axial ribs over all whorls .... *kis* (Winckworth)
b. Shell with axial ribs restricted to last 2 whorls . *chasteri* (Melvill & Standen)
9. a. Aperture with narrow inner lip which has basal ridge behind abapical portion .... *compressa* (Laseron)
b. Aperture with very narrow inner lip with no basal ridge behind abapical portion .... *microthyra* (Martens)

PART 1. TEMPERATE AUSTRALIAN SPECIES

LOCALITY RECORDS: Localities are listed southwards along the east coast of Queensland and N.S.W., then Tasmanian localities are given from north to east and then south and west. Victorian, South Australian and Western Australian records follow from east to west and then northwards.

Pisinna albizona (Laseron). Figs 3c-d; 10a-b; 13a.

?Rissoa cyclostoma.—Henn, 1897: 500 (non T. Woods, 1876).

Estea albizona Laseron, 1950: 270, fig. 38; Iredale & McMichael, 1962: 41.

Estea frauenfeldi.—Laseron, 1950: 269, fig. 36 (non Frauenfeld, 1867).

DIAGNOSIS: Shell—Small, solid, with slightly convex outline, red-brown or orange-brown with white band abapical to suture, smooth or with axial ribs. Surface rather dull.

Protoconch—Dome-shaped, with bulbous top, and of 1½-1¾ weakly convex whorls. Orange-red in colour; with spiral rows of minute pits.

Teleoconch—Outline moderately convex, of 4 very weakly convex whorls. Weak, oblique (prosocline) axial riblets over whole surface — these almost obsolete on first whorl, but may become strong on last 2 whorls and disappear on last 1/3 of body whorl. Very faint, raised spiral lines visible on some parts of shell surface under strong lighting. Base convex, smooth; aperture subcircular, slightly angled adapically. Inner lip thickened, simple, abapical portion raised from base. Outer lip orthocline to slightly opisthocline, thickened internally, without varix. First 2 whorls with inner red chitinous layer showing through yellowish shell, body whorl orange-yellow or pale brown. A narrow, white band abapical to sutures on all or most whorls usually present. Inner lip pale to medium brown, outer lip usually with pale brown edge, pale yellowish behind. Lower base pale-yellowish.

Dimensions	length	diameter
Lectotype	2.80 mm	1.30 mm
Paralectotypes	2.83	1.30
	2.32	1.14
	2.70	1.20
	2.50	1.13
	2.54	1.20

North Harbour, Sydney, N.S.W. (figured by Laseron, 1950 as *E. frauenfeldi* (c. 79210)).

	2.45	1.14
	2.10	1.10
	2.50	1.20
	2.76	1.35 (figured specimen)

Operculum — Typical (fig. 13a).

Radula — Central teeth with broad, blunt middle cusp, proximal end narrower than distal end, 1+1+1 (+ denticle on both sides); lateral teeth 2+2+2, middle cusp broad with bluntly rounded cutting edge. Inner marginals with approximately 10-12 small, sharp cusps, outer marginals finely serrate (fig. 10a-b).

LOCATION OF TYPES: A.M. Lectotype here chosen (C. 79208) and 30 paralectotypes (C. 79209).

TYPE LOCALITY: Point Halliday, N.S.W., alive on algae in rock pools.

ADDITIONAL MATERIAL EXAMINED: North Beach, Bellingen, N.S.W., Voorwinde Coll. (A.M.). S.W. of Solitary Is., N.S.W., 15 m on small boulder, 17 May 1972, coll. P. Hutchings & P. Weate (A.M.). Point Halliday, N.S.W., on algae, Voorwinde Coll. (A.M.). Forster, N.S.W., Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Lighthouse, Port Stephens, N.S.W., 73 m, Voorwinde Coll. (A.M.). Seal Rocks, N. of Newcastle, N.S.W., Voorwinde Coll. (A.M.). Woy Woy, Broken Bay, N.S.W., 13 m, Voorwinde Coll. (A.M.). Pittwater, Broken Bay, N.S.W., 16 m, Voorwinde Coll. (A.M.). Narrabeen Beach, Sydney, N.S.W., Voorwinde Coll. (A.M.). Long Reef, Sydney, N.S.W., on short brown algae, 16 June 1969, coll. W. F. Ponder & P. H. Colman, 3 lots (A.M.). N.E. side of Long Reef, N.S.W., on algae, Voorwinde Coll., 2 lots (A.M.). Fairlight, Sydney, at low water, 23 Dec. 1968, coll. W. F. Ponder; on *Zonaris,* Voorwinde Coll. (A.M.). Harbord, Sydney, N.S.W., sublittoral rocks below R.S.L. club, 14 Aug. 1971, coll. P. Hutchings (A.M.). North Harbour, Sydney, N.S.W., Voorwinde Coll. (2 lots); under stones, C. Laseron Coll. (A.M.). Balmoral, Sydney, 11-14 m, Voorwinde Coll., 2 lots (A.M.). Chinamans Beach, Sydney, N.S.W., 4-7 m, Voorwinde Coll., 2 lots (A.M.). Middle Harbour, Sydney, N.S.W., C. Hedley; 5 m, Voorwinde Coll. (A.M.). West Channel, Port Jackson, Sydney, N.S.W., 27 m, Voorwinde Coll. (A.M.). Sow & Pigs Reef, Port Jackson, N.S.W., 1879, coll. J. Brazier; 11-16 m, Voorwinde Coll. (A.M.). Bottle & Glass Rocks, Sydney, N.S.W., Voorwinde Coll.; 9 Oct. 1968, coll. W. F. Ponder (A.M.). Ny-ar-gine Point, Sydney, N.S.W., on small algae, 19 Dec. 1968, coll. A.M. party (A.M.). Port Jackson, N.S.W., Hargraves Coll. (A.M.). Kurnell, Botany Bay, Sydney, N.S.W., Voorwinde Coll. (A.M.). Gunnamatta Bay, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Cronulla, Sydney, N.S.W., Voorwinde Coll., 2 lots (A.M.). Honeymoon Beach, Jervis Bay, N.S.W., under stones; in beach sand, 18 Jan. 1969, coll. W. F. Ponder & N. Coleman (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.). S. side of Ulladulla, N.S.W., outside breakwater on moderately exposed rock platform, on coralline algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Batemans Bay, N.S.W., Voorwinde Coll. (A.M.). Off Gabo Is., Vic., 26 m, coll. R. Bell (A.M.). Cape Everard, Vic., 18 m, 16 Feb. 1973, coll. P. Hutchings (A.M.).

DISTRIBUTION AND HABITAT: Common in N.S.W. at least as far south as Batemans Bay and north to Bellingen on low tidal and shallow sublittoral algae. One specimen from Cape Everard, S.E. Victoria is known but the record needs confirmation (see fig. 18).

REMARKS: Similar to *frenchiensis* (Gatliff & Gabriel) but differs in having a slightly more elongate shell, in often developing axial ribs on the last whorl (*frenchiensis* is always smooth) and in usually having a distinct, rather broad, whitish band abapical to the sutures which is absent or only a narrow line in *frenchiensis.* The radulae show a number of differences, the most obvious being the relative size of the middle cusp on the central teeth (cf. fig. 10a-b and fig. 11e).

Laseron's (1950: 269) *Estea frauenfeldi* (fig. 3c) is the ribbed form of *albizona* and not *P. frauenfeldi* (Frauenfeld). Our figured specimen is taken from the same lot as Laseron's figured specimen.

Pisinna approxima (Petterd). Figs 2e-g; 3i-l; 11a-b.

Rissoa cyclostoma var *rosea* T. Woods, 1877b: 153; May, 1903: 112, text fig. 9 (non Deshayes, 1863 and Hutton, 1873).

Rissoa approxima Petterd, 1884: 138; Tate & May, 1901: 393, pl. 26, fig. 69; Pritchard & Gatliff, 1902: 108.

Rissoa approximata (sic).—Tryon, 1887: 392.

Rissoia (Microsetia) approxima.—Tate, 1899: 234.

Rissoa woodsi Pritchard & Gatliff, 1902: 104 (nom. nov. pro. *Rissoa cyclostoma* var *rosea* T. Woods, 1877); Pritchard & Gatliff, 1906: 63.

Amphithalamus approximus.—Hedley, 1911: 105.

Amphithalamus woodsi.—Hedley, 1911: 108.

Estea approxima.—May, 1921: 52; May, 1923: pl. 24, fig. 1; Cotton, 1944: 287.

Estea woodsi. — May, 1921: 52.

Estea gemma Laseron, 1950: 271, fig. 43; Iredale & McMichael, 1962: 41.

Pisinna approxima.—Macpherson & Gabriel, 1962: 91.

DIAGNOSIS: Shell—Small for genus, rather solid, with outlines slightly convex. Surface shining, smooth. Colour usually wine-red, slightly translucent, inner lip thin.

Protoconch—Dome-shaped, approximately 1½ whorls, wine-red in colour and minutely pitted.

Teleoconch—Spire outlines slightly convex, of 3 convex whorls. Surface smooth, glossy, with false-margined sutures. Base convex; aperture subcircular, slightly angled above. Inner lip a glaze on parietal region, abapical portion not much raised from base. Outer lip thin and sharp, orthocline. Varix absent. Colour typically wine-red with a yellowish aperture and base, but colour varies from pink with a white aperture and base, to deep purple-brown with a yellow-brown aperture and base.

Dimensions:	length	diameter
Lectotype	1.65 mm	0.75 mm
Paralectotype	1.58	0.76
Syntypes of *Rissoa*	1.42	0.61 (fig. spec.)
cyclostoma var *rosea*	1.46	0.65
Estea gemma Laseron		
Lectotype	1.43	0.36
Paralectotype	1.50	0.65
Figured specimens	1.52	0.70
	1.56	0.74
	1.58	0.72
	1.76	0.80

Operculum—Typical.

Radula—Central tooth with narrow sharp cusps, middle cusp longest 1 + 1 + 1 (+ denticle on both sides); lateral teeth 2 + 1 + 2, all cusps long and sharp; inner marginal teeth with about 12 sharp cusps; outer marginal with about 8 sharp, small cusps (fig. 10a-b).

LOCATION OF TYPES: *Rissoa approxima* T. M. Lectotype and paralectotype, here chosen (7744/E403, TM10, 891).

Rissoa cyclostoma var *rosea* T.M. 2 syntypes (7766/E425, TM5476).

Estea gemma A.M. Lectotype (C. 79211) and 17 paralectotypes (C. 79212) here chosen.

TYPE LOCALITIES: *Rissoa approxima.* Tamar Heads, Tasm.

Rissoa cyclostoma var *rosea.* Blackmans Bay, Tasm.

Estea gemma. Crookhaven Heads, N.S.W., on algae.

ADDITIONAL MATERIAL EXAMINED: Ballina, N.S.W., open coast under stones, 6 Jan. 1969, coll. W. F. Ponder (A.M.). Forster Beach, N.S.W., Voorwinde Coll. (A.M.). Hawks Nest, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll., 5 lots (A.M.). Off Port Stephens, N.S.W., 64 m, Voorwinde Coll. (A.M.). Port Stephens, N.S.W., Voorwinde Coll., 3 lots (A.M.). Patonga Beach, Hawkesbury River, N.S.W., Voorwinde Coll. (A.M.). Collaroy Beach, Sydney, N.S.W., Voorwinde Coll., 2 lots (A.M.). Long Reef, Collaroy, Sydney, N.S.W., J. Voorwinde Coll., 2 lots (A.M.). Fairlight, Sydney, N.S.W., 3-5 m, Voorwinde Coll. (A.M.). Manly, Sydney, N.S.W., Voorwinde Coll., 2 lots (A.M.). Forty Baskets Beach, Sydney, N.S.W., Voorwinde Coll. (A.M.). Middle Harbour, Sydney, N.S.W.; 5 m, Voorwinde Coll.; coll. C. Hedley (A.M.). Chinamans Beach, Sydney, N.S.W., 3-5m, Voorwinde Coll., 3 lots (A.M.). E. side of Sow & Pigs Reef, Sydney Harbour, N.S.W., near the rocks, rocky bottom, 1865, coll. J. Brazier (A.M.). Port Jackson, Sydney, N.S.W., dredged, Voorwinde Coll. (A.M.). Sydney Harbour, N.S.W., coll. C. Hedley (A.M.). Little Coogee Bay, Sydney, N.S.W., 21 Apr. 1895, coll. J. Brazier (A.M.). Cronulla, Sydney, N.S.W., Voorwinde Coll. (A.M.). Werri Beach, near Gerringong, N.S.W., Voorwinde Coll. (A.M.). Crookhaven Heads, southern N.S.W., C. Laseron Coll.; on algae, Voorwinde Coll., 2 lots (A.M.). Ulladulla, N.S.W., Voorwinde Coll., 2 lots (A.M.). S. side of Ulladulla, N.S.W., outside breakwater on moderately exposed rock platform, on coralline algae, 5 Jan. 1970, coll. W. F. Ponder and P. H. Colman (A.M.). Batemans Bay, N.S.W., Voorwinde Coll. (A.M.). Shelly Beach, Bermagui, N.S.W., Voorwinde Coll. (A.M.). Eden Harbour, N.S.W., Voorwinde Coll. (A.M.). Bass Strait, pres. W. L. May (A.M.). Deal (Erith) Is., Bass Strait, N.E. Tasm., on algae, 6 m, 6 May 1974, coll. S.A. Shepherd (A.M.). Stanley, N. Tasm. (T.M.). Freestone Cove, Wynyard, N. Tasm., on algae, low tide, 12 Oct. 1971, coll. J. Beu (A.M). Badger Head, N. Tasm. (T.M.). West Head, Green Beach, N. Tasm., rocky shore, under stones, in lower littoral amongst coralline algae, Mar. 1973, coll. R. Kershaw (A.M.). Ansons Bay, E. Tasm., 28 Dec. 1966, coll. A. Dartnall (T.M.). Tamar Heads, Tasm., Oct. 1913 (A.M.). Spring Beach, E. Tasm., 2 Feb. 1970, coll. E. Turner (T.M.). Reidle Bay, Maria Is., E. Tasm., Sept. 1967, coll. J. Thwaites (T.M.). Dunally, S. Tasm. (T.M.). Eaglehawk Neck, S. Tasm. (A.M.). Eaglehawk Neck, S. Tasm., pres. C. Hedley, 7 lots (A.M.). Eaglehawk Neck, S. Tasm., 3 June 1967, coll. A. Dartnall, 2 lots (T.M.). Pirates Bay, Eaglehawk Neck, S. Tasm, (30 Mar.-2 Apr. 1970) on *Caulerpa*; in beach sand under *Durvillea* holdfasts; under stones; on intertidal rocks on coralline algae; coll. W. F. Ponder, 10 lots (A.M.). Wedge Bay, S. Tasm., 7 m, Voorwinde Coll. 2 lots (A.M.). Browns River, Tasm., pres. C. Hedley (A.M.). Frederick Henry Bay, S. Tasm., pres. W. L. May (A.M.; S.A.M.). 3 km N. of Granville Harbour, W. Tasm., 23 Nov. 1967, coll. A Dartnall (T.M.). Marrawah, N.W. Tasm., Jan. 1956, coll. E. Aves (T.M.). Off Gabo Is., Vic., 25 m, coll. R. Bell (A.M.). Cape Everard, Vic., 6-9 m, in holdfasts of *Phyllospora*, Feb. 1973, coll. P. Hutchings (A.M.). Bastion Point, Vic., intertidal crevice fauna, 19 Feb. 1973, coll. P. Hutchings, 2 lots (A.M.). N.E. side Bastion Point, Mallacoota, Vic., coralline and short brown algae on exposed rocks, 9 Jan. 1970, coll. W. F. Ponder & P. H. Colman, 2 lots (A.M.). Red Bluff, near Lake Tyers, Vic., lower littoral, on small rocky, exposed point on short red algae; on short brown algae; 11 Jan. 1970, coll. W. F. Ponder & P. H. Colman, 3 lots (A.M.). Western Port, Vic., (A.M.); Gatliff Coll., 2 lots (N.M.V.). Cowes, Phillip Is., Vic., Voorwinde Coll. (A.M.). Shoreham, Vic., Gatliff Coll. (N.M.V.). Flinders, Vic., in beach sand, Voorwinde Coll. (A.M.). Flinders Ocean

Beach Platform, Vic., lower littoral rockpools, beneath stones and on algae, 4 May 1967 (2 lots) coll. B. J. Smith; short algae washings, 16 Feb. 1969, coll. W. F. Ponder & B. J. Smith. Kilcunda, Vic., Gabriel Coll. (N.M.V.). Portsea, Vic., Gatliff Coll. (N.M.V.; A.M.). Moonlight Bay, Vic., rock platform, 11 Mar. 1973, coll. Marine Study Group (A.M.). Port MacDonnell, E.S.A., Verco Coll. (S.A.M.). Off Middle Point, near Cape Northumberland, S.A., 13 m, on algae, 19 Mar. 1974, coll. S. A. Shepherd (A.M.). Robe, S.A., Verco Coll. (S.A.M.). Guichen Bay, S.A., Verco Coll. (S.A.M.). Between Cape Jaffa, Vic., & Kangaroo Is., S.A., 75-155 m, 24-26 July 1962, H.M.A.S. "Gascoyne" G2/71, 72, 76, 77/62 (A.M.). N.W. of Cape Borda, S.A., 64 m (S.A.M.). 3 km S. of Normanville, S.A., on rock strewn platform, medium exposure, 12 Jan. 1971, coll. W. F. Ponder (A.M.). Normanville, S.A., Voorwinde Coll. (A.M.). Glenelg, S.A., Verco Coll. (S.A.M.). St. Vincents Gulf, S.A., Voorwinde Coll. (A.M.). Hardwicke Bay, S.A., pres. H. L. Kesteven (A.M.). Arno Bay, S.A., Garrard Coll. (A.M.). Tumby Bay, S.A., coll J. Thompson, Voorwinde Coll. (A.M.). The Heap, Tumby Bay, N. of Port Lincoln, S.A., coll J. Thompson, Voorwinde Coll. (A.M.). 64 km S. of Cape Wiles, S.A., 183 m, "Endeavour", Aug. 1909 (A.M.). Venus Bay, S.A., Verco Coll. (S.A.M.). Fowlers Bay, S.A., Verco Coll. (S.A.M.). Kilcarnup, N. side of Margaret River, S.W.A., shell sand on beach, 1 Jan. 1972, coll W. F. Ponder (A.M.). Cape Naturaliste, S.W.A., in shell sand, Mar. 1970, coll. J. Hewitt (A.M.). Murchison River mouth, W.A., on rocks at S. side, Oct. 1967 & Oct. 1969, coll. F. H. Plant (A.M.). Yardie Creek, S. of N.W. Cape, W.A., seaward side of mouth, Sep. 1969, coll. F. H. Plant (A.M.). (The last 2 records require confirmation.)

FOSSIL RECORD: Upper Pliocene: Cameron Inlet Formation, Hill's Dam at foot of Dutchman (E. side), Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.).

DISTRIBUTION AND HABITAT: Northern N.S.W. to North West Cape, W. Australia. Lives in the lower intertidal and shallow sublittoral zones on algae, and beneath rocks and stones on open coasts (see fig. 15). The deep-water records refer to dead shells which are probably remnants of a Pleistocene shore-line. Known from the Upper Pliocene of Flinders Island.

REMARKS: This species is rather variable in shape (see figs 3i-l), size and colour. Some populations from the same type of habitat are very constant; others are variable. At one extreme is a form which is usually pink and has a relatively broad spire and small aperture, with rather flat whorls and a swollen spire outline. This form grades through to a longer spired, dark-coloured form with an expanded aperture and convex whorls. This latter form is the one normally encountered in N.S.W. and was named *gemma* by Laseron. Similar shells are seen through other parts of the range of *approxima* and they cannot be satisfactorily separated from the typical form so that *gemma* is here considered to be a synonym of *approxima*.

Pisinna approxima is a distinctive species easily identified with its usually convex whorls, thin inner lip, tall spire and glossy red shell. Some forms of *approxima* approach *vincula* (Laseron) and *circumlabra* nov. (see 'remarks' under those species).

Two lots in the S.A.M. (Venus Bay and Glenelg) identified and recorded by Cotton (1944) as *Scrobs pellyae* (Nevill, 1881), are *P. approxima*. Most of the remainder of Cotton's *pellyae* are *Badepigrus petterdi* (Brazier, 1895), with which *pellyae* Nevill is probably synonymous and is the earlier name.

Pisinna bicolor (Petterd). Fig. 6g.

Rissoa bicolor Petterd, 1884: 137; Pritchard & Gatliff, 1902: 103.

Amphithalamus bicolor.—Hedley, 1911: 106.

DIAGNOSIS: Shell—Of moderate size for genus, solid, smooth, with a tall spire and rounded body whorl.

Protoconch—1½ whorls, dome-shaped, typical, orange to dark red.

Teleoconch—Spire tall, outlines straight, whorls 4, flat, body whorl sometimes slightly swollen, with its suture narrowly stepped. Periphery evenly rounded or with very slight subangle. Surface smooth, shining, with very weak growth lines. Aperture oval to subcircular. Inner lip rather broad, slightly advanced over parietal region. Adapical section of inner lip considerably raised from base. Varix rather prominent, close behind edge of outer lip. Colour dark purple fading to reddish-purple or pinkish-red on spire, with orange-brown or yellowish-brown body whorl; white line at abapical edge of suture on spire, becoming a broad white band on last two whorls. Inner lip orange-brown, outer lip white, aperture brown within.

Dimensions:	length	diameter
Neotype	3.96 mm	1.80 mm
(original dimensions given as 3.5 mm × 2 mm)		
Paratype	3.40	1.50

LOCATION OF TYPES: T.M. (7745/E404, TM 5479) neotype and one paratype.

TYPE LOCALITY: "North coast" of Tasmania (error?). Locality of neotype "South Tasmania".

ADDITIONAL MATERIAL EXAMINED: Derwent Estuary, Tasm., T. A. Garrard Coll. (A.M.). Tasmania, exch. C. E. Beddome, 3 lots (A.M.); 2 lots (N.M.V.). N. of Cape Lodi, E. Tasm., 33 m, 41°50'S, 148°17.3'E, fine medium sand, 24 Mar. 1973, B.M.R. stn S73-2025, M.T. "Sprightly", coll. P. H. Colman (A.M.). Portsea, Vic. pres. J. H. Gatliff (A.M.).

DISTRIBUTION AND HABITAT: See remarks and fig. 17.

REMARKS: The type locality is probably erroneous as no other specimens have been seen from the "North coast" of Tasmania and it is certainly not "abundant at low water" as stated in the original description. The type is apparently lost but the description and dimensions leave little doubt as to the identity of this species. The erection of a neotype is considered to be advisable because Petterd's type material has not been located and there has been some confusion over the identity of this species. One of us (W.F.P.) has personally searched the N.M.V., the A.M., the Queen Victoria Museum, Launceston and the B.M.N.H. but has been unsuccessful in locating any specimens of *bicolor* labelled "North coast" of Tasmania among specimens presented by Petterd. Mr. A. Dartnall of the Tasmanian Museum has indicated that there is also none of this material in that museum. Several lots from other localities, however, identified as *P. bicolor* and originating from Petterd have been examined.

The specimen chosen as the neotype is probably part of the original material obtained from Petterd. As Petterd's type locality is assumed to be in error, the different location for the neotype is justified.

The original description of *bicolor* fits *frenchiensis* moderately well, although the dimensions (3.5 mm × 2 mm) are greater than they would be for that species. *Pisinna nitida* nov. is even larger and does not have a littoral habitat. The original description is sufficiently vague not to have any outstanding discrepancies with *frenchiensis* or *nitida* except that the colour is given as "rich-brown, with a broad sordidly white band next to the suture".

This species is presumably restricted to relatively small areas in the shallow sublittoral zone as it has only been obtained in one of the numerous shelf bottom samples and in none of the littoral samples seen from Tasmania during the present study. A large number of specimens in several lots obtained from C. E. Beddome labelled "Tasmania" in the A.M. all have a very similar appearance and were probably collected from the same locality. They may even represent part of the original lot obtained from Petterd.

This species is similar to *P. tasmanica* (T. Woods) in having an elongate, often pinkish coloured shell. *P. bicolor* is larger, and is completely smooth, whereas *tasmanica* usually has at least weak axial ornament on the body whorl. In addition, the two species differ in apertural details, especially in the outer lip being opisthoclinal in *bicolor* (whereas it is suborthoclinal in *tasmanica*) and in the strong varix in *bicolor*, that of *tasmanica* being weak or absent.

This species name has been mistakenly used for a large species widespread on the continental shelf, which is described as *P. nitida* herein.

Typical *P. bicolor* has not been previously figured. The specimen figured by Gatliff & Gabriel (1913a) as this species is *P. tasmanica* from off Wilsons Promontory. Pritchard & Gatliff (1902) record *bicolor* from Portsea, Victoria and specimens in the A.M. from that locality (donated by J. H. Gatliff) are *P. bicolor* (Petterd). However, a lot of 4 specimens in the Gatliff collection in the N.M.V. from Portsea, and also identified as *bicolor*, are *P. nitida*. Cotton's (1944) deep-water South Australian records refer to *P. voorwindei* nov.

Pisinna castella (Laseron). Fig. 2a.

Estea castella Laseron, 1950: 268, fig. 32.

Nodulestea castella.—Iredale, 1955: 81; Iredale & McMichael, 1962: 41.

DIAGNOSIS: Shell—Small, solid, thick, opaque, with 3 spiral cords and numerous axial ribs.

Protoconch—Conical, 1¾ whorls, weakly convex, slightly stepped at sutures. Dark reddish-orange (type faded to yellowish) in colour, with minutely pitted surface.

Teleoconch—Spire convex; 3-3¼ whorls, channelled at sutures, flat or weakly concave between them. First whorl of teleoconch with 2 spiral grooves one adapical and one abapical to sutures. A median spiral groove commences on second whorl of teleoconch and this becomes equal in strength to other grooves on body whorl, lower groove becoming weak on last 1/3 of body whorl. Numerous axial ribs on all whorls (21 on penultimate whorl in type), which extend over base, cut up by grooves to form 3 spiral rows of nodules. Aperture subcircular; inner lip broad, abapical portion much separated from base. Outer lip orthocline or slightly opisthocline. Base rather flat with weak basal ridge. Varix broad, moderately strong. Deep wine-red in colour, mostly due to inner chitinous layer. Edges of aperture yellowish.

Dimensions:	length	diameter
Holotype	1.88 mm	0.90 mm
Fairlight, Sydney in 3-5 m	1.75	0.90

LOCATION OF TYPE: A.M. Holotype (C. 94734).

TYPE LOCALITY: Off Crookhaven, N.S.W., 55-64 m.

ADDITIONAL MATERIAL EXAMINED: Trawled N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll. (A.M.). Moreton Bay, S. Qld (A.M.). Off Flatrock, N. Stradbroke Is., S. Qld, 24-30 m, on algae, 2 Aug. 1971, coll. R. Ibara (A.M.). Off Crowdy Head, N.S.W., 32°38.9′S, 153°0.8′E, 91 m, 16 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Collaroy, Sydney, N.S.W., Voorwinde Coll. (A.M.). Narrabeen, Sydney, N.S.W., Voorwinde Coll., 2 lots (A.M.). The Spit, Middle Harbour, Sydney, N.S.W., Voorwinde Coll. (A.M.). Fairlight, Sydney, N.S.W., 3-5 m, on red algae, Voorwinde Coll. 2 lots (A.M.). North Harbour, Sydney, N.S.W., Voorwinde Coll. (A.M.). Balmoral, Sydney, N.S.W., 11-15 m, Voorwinde Coll. (A.M.). Chinamans Beach, Sydney, N.S.W., 3-7 m,

Voorwinde Coll. (A.M.). Vaucluse, Sydney, N.S.W., Feb. 1953, coll. N. Jackson; under stones below low tide, N. Jackson Coll. (A.M.). Bottle and Glass Rocks, Sydney, N.S.W., 1967, pres. J. Campbell, Voorwinde Coll. (A.M.). Sow & Pigs Reef, Sydney, N.S.W., 11-16 m, Voorwinde Coll. (A.M.). E. side of Sow & Pigs Reef, Sydney, N.S.W., 4 m, 1865, coll. J. Brazier, 2 lots (A.M.). Kurnell, Botany Bay, Sydney, N.S.W., Voorwinde Coll. (A.M.). Gunnamatta Bay, N.S.W., Voorwinde Coll. (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.). S. side of Ulladulla, N.S.W., outside breakwater on moderately exposed rock platform, on small brown algae, 5 Jan. 1970, coll. W. F. Ponder and P. H. Colman (A.M.). S. side of Ulladulla, N.S.W., inside breakwater, on sheltered reef, on small brown algae and on coralline algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Twofold Bay, N.S.W., 46 m, Voorwinde Coll. (A.M.).

DISTRIBUTION AND HABITAT: Southern Queensland (vicinity of Moreton Bay) to southern N.S.W. (Twofold Bay), occasionally found in the lowest portion of the intertidal zone but usually located in the sublittoral where it extends into moderately deep water. It has been found living on algae and beneath stones (see fig. 19).

REMARKS: This is the type species of Iredale's *Nodulestea* and, as Laseron (1950) pointed out, it is very similar, and probably closely related to *P. olivacea olivacea* (Frauenfeld). The main distinguishing feature is the presence of 2 spiral grooves on the body whorl in addition to the groove also present in *olivacea olivacea* which forms the band of nodules abapical to the sutures. The additional grooves cut the axial ribs into 2 additional spiral rows of nodules.

Pisinna circumlabra sp. nov. Figs 3a-b; 11d.

Estea subfusca.—Gabriel, 1956: 9 (non Hutton, 1873).

DIAGNOSIS: Shell—Minute, broadly to medium pupoid, solid, smooth, shining, orange-red spire and yellowish body whorl and a large, round aperture with wide inner lip.

Protoconch—Dome-shaped, of 1½ whorls, wine red with typical sculpture.

Teleoconch—Spire typically short, broad (but sometimes medium), lightly convex, of 2¾-3 slightly convex whorls, the last very large. Surface smooth except for growth lines and exceedingly faint spiral scratches. Aperture relatively large, subcircular, inner lip broadly expanded across parietal region, edge of adapical half of lip almost at right angles to longitudinal axis. Abapical portion well separated from base but not much expanded. Outer lip orthocline, with no varix. Periphery and base evenly convex. Colour of spire whorls reddish-orange or reddish-purple (due to inner layer showing through). Body whorl pale yellowish-brown, aperture (including inner lip) yellowish-white.

Dimensions:	length	diameter
Holotype	1.82 mm	0.92 mm
Figured paratype	1.62	0.87

Operculum—Typical.

Radula—Central teeth 2 + 1 + 2, lateral cusps sharp, narrow, median cusp narrow, cutting edge rounded, a little longer than adjacent cusps. Lateral teeth with long, sharp lateral cusps, 2 + 1 + 4, median cusp blunt, slightly longer than adjacent cusps. Inner marginal teeth with about 14 small, sharp cusps, outer marginals denticulate (fig. 11d).

LOCATION OF TYPES: A.M. Holotype (C. 95783), figured paratype (C. 95782), 40 paratypes (C. 95720) and 20 paratypes (C. 95721).

TYPE LOCALITY: Pirates Bay, Eaglehawk Neck, S.E. Tasm., on intertidal rocks, exposed N. end, on *Lessonia* holdfasts, 2 Apr. 1970, coll. W. F. Ponder (C. 95783, C. 95782, C. 95720). As above, on *Caulerpa*, 30 March, 1970 (C. 95721).

ADDITIONAL MATERIAL EXAMINED: 24 km off Twofold Bay, N.S.W., 75-154 m, 37°26'S, 150°15'E, 19 June 1962, H.M.A.S. "Gascoyne", G2/58-59/62 (A.M.). East Cove, Deal Is., Bass Strait, N.E. Tasm., 147°20'E, 39°30'S, 6-15 m, 3-10 May 1974, coll. S. A. Shepherd (A.M.). Goat Is., near Ulverstone, N. Tasm., on coralline algae, 18 Mar. 1975, coll. W. F. Ponder & R. Kershaw (A.M.). E. of Grassy, King Is., N. Tasm., ca. 58-77 m, H.M.A.S. "Gascoyne" G2/68-70/62, 23 July 1962 (A.M.). Near Elephant Shoal Reef, 6½ km S.E. of King Island, Bass Strait, 14 m (?), 1937 (N.M.V.). Pirates Bay, Eaglehawk Neck, S.E. Tasm., on intertidal rocks on brown algae; on coralline algae, under *Durvillea* holdfasts, 30-31 Mar. 1970, coll. W. F. Ponder (A.M.). Bond Bay, Pt. Davey, S.W. Tasm., Feb. 1968 (T.M.). 3 km N. of Granville Harbour, W. Tasm., 23 Nov. 1967, coll. A. J. Dartnall (T.M.). S.S.E. side of Gabo Is., E. Vic., red algae, 28 m, Feb. 1973, coll. P. Hutchings (A.M.). S.E.E. side of Gabo Is., E. Vic., below lighthouse, in detritus 15-18 m, Feb. 1973, coll. P. Hutchings (A.M.). 58 km S. of Cape Conran, off Gippsland, Vic., stn. 10, 148°38'40"E, 38°18'20"S, 220-266 m, "Esso-Gipps", May 1969, coll. C. Phipps (A.M.). Flinders Ocean Beach Platform, Vic., lower littoral, under stones and on algae, 4 May 1967, coll. B. J. Smith (A.M.). Flinders, Vic. (N.M.V.). Ocean side of Queenscliff, Port Phillip, Vic., on rocky platform, on small algae, 13 Feb. 1969, coll. W. F. Ponder, 2 lots (A.M.). Point Lonsdale, Vic., near Geelong, under stones and large brown algae, 18 Sept. 1973, 2 lots, coll. W. F. Ponder & R. Burn (A.M.). Portland, Vic., Gabriel Coll. (N.M.V.). Guichen Bay, S.A., Verco Coll. (S.A.M.).

DISTRIBUTION AND HABITAT: Bass Strait, Tasmania and Victoria, lower littoral and sublittoral, under stones and on algae (see fig. 18). Dead material also found on the continental shelf.

REMARKS: The typical broad form of this species is similar to *P. dubitabilis* (Tate) and *megastoma* sp. nov. in shape but differs in its broadly expanded inner lip, that of *dubitabilis* and *megastoma* being narrow with a concave edge. *P. circumlabra* has a paler coloration than any of the sympatric smooth species except *approxima* which is smaller, narrower, with a thinner shell, more convex whorls, more expanded aperture and a narrow, thin, inner lip. The smaller forms of *frenchiensis* also approach the narrower forms of *circumlabra* in shape but the inner lip is always narrower and the two species differ in colour. *P. vincula* is similar, but has a more cylindrical shape and an angled to subangled body whorl.

Pisinna columnaria (Hedley & May). Fig. 2d.

Rissoa columnaria Hedley & May, 1908: 117, pl. 22, fig. 9.

Estea columnaria.—Iredale, 1915: 451; May, 1921: 54; May, 1923: pl. 24, fig. 4; Cotton, 1944: 288.

DIAGNOSIS: Shell—Small, elongate — pupoid, moderately solid. Spire pinkish and base yellow; shining, with very fine axial riblets.

Protoconch—Dome-shaped, reddish, minutely pitted, of 1½ weakly convex whorls.

Teleoconch—Spire outline very weakly convex; whorls 4, weakly convex, usually with an indistinct ridge abapical to the suture followed by a shallow furrow. Numerous, close set fine axial riblets on all whorls, these being crisper on the last two whorls than on others. Ribs prosocline, curved on most of shell, but nearly straight on last half of body whorl and extend on to base. A trace of spiral sculpture between ribs (only visible under high magnification). Base weakly convex, usually with very weak to moderate basal ridge. Aperture protrudes beyond line of spire. Inner lip broad, not much elevated from base; outer lip horizontal, considerably thickened within. Varix moderate to weak, immediately behind outer lip. Colour whitish-yellow, with reddish spire (all material somewhat faded).

Dimensions:	length	diameter
Lectotype	2.65 mm	1.00 mm
Paralectotypes	2.75	1.05
	2.60	1.00

LOCATION OF TYPES: A.M. Lectotype (C. 29047) and 12 paralectotypes (C. 79572). Several paralectotypes in T.M. (7142/E11, C. 331; 442) N.M.V., and S.A.M.

TYPE LOCALITY: 11 km E. of Cape Pillar, S.E. Tasm., in 183 m.

ADDITIONAL MATERIAL EXAMINED: 3 km S. of Tasman Head, South Bruny Is., S.E. Tasm., 43°33.4′S, 147°19.2′E, 73 m, 24 Mar. 1970, coll. W. F. Ponder, F.R.V. "Penghana" (A.M.). D'Entrecasteaux Channel, S. Tasm., 24 Apr. 1965, Voorwinde Coll., H.M.A.S. "Moresby" (A.M.) (locality doubtful). N.W. of Sandy Cape, N.W. Tasm., 41°09.4′S, 144°10.6′E, 132 m, 14 Apr. 1973, B.M.R. stn S73-2120, M.T. "Sprightly" (A.M.).

DISTRIBUTION AND HABITAT: 73-183 metres, Tasmania (see fig. 19).

REMARKS: This species is similar to *P. micronema* (Suter, 1898) from southern New Zealand, but differs in its narrower shell, weaker spiral and axial sculpture, and in the aperture being less raised from the base.

The record of *columnaria* by Gatliff & Gabriel (1913b: 78) from off Wilsons Promontory refers to *P. oblata* (Laseron).

P. columnaria differs from all others in Australian waters by its long, narrow spire and the weak, close, axial threads on all whorls.

Pisinna costata (Hedley). Figs 4a-b; 12a-b.

Amphithalamus costatus Hedley, 1911: 104, pl. 19, fig. 24.

Scrobs costatus.—Cotton, 1944: 311.

Estea hoggartae Gabriel, 1956: 6, fig. 4.

DIAGNOSIS: Shell—Small, pupoid, solid, shining, with strongly convex whorls and heavy, flat, close axial ribs.

Protoconch—Dome-shaped, 1½ whorls, with caniculate suture. Sculptured with weak spiral ridges and minute pits (fig. 12a-b). Varix strong, colour pinkish to yellowish-brown, but fades to white.

Teleoconch—Spire lightly convex; 3¼-3½ whorls, very strongly convex, sutures caniculate. Axial ribs heavy, flat-topped, with very narrow, rather deep interspaces. Ribs extend over weakly convex base. Aperture subcircular, lips thickened within; outer lip opisthocline, inner lip slightly raised above parietal region. Varix very weak or absent. Colour yellowish-white, with rather pale reddish-purple inner layer showing through on spire. Fades to white.

Dimensions:	length	diameter
Holotype	3.10 mm	1.40 mm
Figured paratype of *Estea hoggartae*.	3.15	1.45

LOCATION OF TYPES: *Amphithalamus costatus.* A.M. Holotype (E. 4253) and 17 paratypes (E. 4253 and C. 31878).

Estea hoggartae. N.M.V. Holotype (F. 16127) and 3 paratypes (F. 16128).

TYPE LOCALITIES: *Amphithalamus costatus.* 64 km, S. of Cape Wiles, S.A., 183 m, F.R.V. "Endeavour".

Estea hoggartae. On Bass Strait Cable, between King Island and Stanley, Tasmania. Probably near Elephant Shoal Reef, 6½ km S.E. of King Island, Bass Strait (depth uncertain as it is not clear exactly where this material was collected).

ADDITIONAL MATERIAL EXAMINED: Off S.W. of West Point, N.W. Tasm., 41°09.2'S, 144°24.2'E, 88 m, 14 Apr. 1973, B.M.R. stn 2121, M.T. "Sprightly" (A.M.). 3 km S. Tasman Head, S. Bruny Is., S.E. Tasm., 43°33.45'S, 147°19.21'E, 73 m, 24 Mar. 1970, coll. W. F. Ponder, F.R.V. "Penghana" (A.M.). D'Entrecasteaux Channel, S. Tasm., 24 Apr. 1965, Voorwinde Coll., H.M.A.S. "Moresby" (A.M.) (locality doubtful). E. of Grassy, King Is., Tasm., 58-77 m, 23 July 1962, H.M.A.S. "Gascoyne", stn G2/68-70/62, 2 lots (A.M.). Off Beachport, S.A., 200 m, Verco Coll., 2 lots (S.A.M.). Off Cape Jaffa, S.A., 164 m, Verco Coll., 2 lots (S.A.M.). N.E. of Cape Borda, S.A., 113 m, Verco Coll., 2 lots (S.A.M.). 64 km S. of Cape Wiles, S.A., 182 m (S.A.M.) (topotypes). Between Cape Jaffa and Kangaroo Is., S.A., 75-155 m, 24-26 July 1962, H.M.A.S. "Gascoyne", stn G2/71, 72, 76, 77/62 (A.M.). 80 km S.W. of Cape Adieu, Gt. Aust. Bight, S.A., 32°42'S, 131°27'E, 79 m, 4 July 1962, H.M.A.S. "Gascoyne", stn G2/90/62 (A.M.). Gt. Aust. Bight, S.A., 33°05'S, 128°40'E, 75 m, 5 July 1962, H.M.A.S. "Gascoyne", stn G2/97/62 (A.M.). Off St. Francis Is., S.A., 64 m, Verco Coll., 2 lots (S.A.M.). St. Vincent Gulf, S.A., 46 m, Verco Coll. (S.A.M.). Spencers Gulf, S.A., 73 m, Verco Coll. (S.A.M.). Investigator Strait, S.A., 36 m, Verco Coll. (S.A.M.). E. of Hood Point, W.A., 34°21'S, 121°16'E, 79 m, 9 July 1962, H.M.A.S. "Gascoyne", stn G2/109/62 (A.M.). E. off Cheyne Bay, W.A., 34°55'S, 119°00'E, 75 m, 7 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/150/62, 2 lots (A.M.). S. of Wilson Inlet, W.A., 35°12'S, 117°00'E, 73-77 m, 8 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/160/62 (A.M.). W. of Jurien Bay, W.A., 30°45'S, 114°51'E, 143 m, 11 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/180/62 (A.M.).

DISTRIBUTION AND HABITAT: Tasmania to S.W. Australia on the continental shelf in 36-200 metres (see fig. 16).

REMARKS: This species is readily distinguished by its broad, flattened axials which have very narrow interspaces between them, and its deep sutures.

A possible example of mimicry either of, or by, *P. costata* occurs with a species of *Rissoina*, *R. axisculpta* Cotton, which occurs sympatrically and has virtually identical sculpture on the teleoconch. This style of sculpture is very unusual and has not been seen in any other Australian prosobranch known to the writers.

Estea hoggartae Gabriel is identical to *P. costata*, and as *hoggartae* was not contrasted with *costata*, it can only be assumed that Gabriel was not aware that his species had already been described.

Pisinna dubitabilis (Tate). Fig. 2j.

Rissoa dubius Petterd, 1884: 137; Tryon, 1887: 368; Tate & May, 1901: 391, pl. 26, fig. 71; Pritchard & Gatliff, 1906: 63; May, 1920: 72 (non Defrance, 1827, non Johnston, 1884).

Rissoa dubitabilis Tate, 1899: 232 (nom. nov. pro *Rissoa dubius* Petterd, 1884).

Amphithalamus dubitabilis.—Hedley, 1911: 106.

Estea dubitabilis.—May, 1921: 50; May, 1923: pl. 23, fig. 27.

Dardanula dubitabilis.—Cotton, 1944: 305.

Eatoniella dubitabilis.—Macpherson & Gabriel, 1962: 94.

DIAGNOSIS: Shell—Small, broadly pupoid, solid, smooth, surface somewhat glossy.

Protoconch—1½ whorls, dome-shaped, with spiral rows of minute pits, very dark purple-red.

Teleoconch—Light convex whorls and spire, of 2¾ whorls, body whorl large. Smooth except for growth lines. Aperture large for genus, only moderately thickened, obliquely oval; inner lip narrow, outer edge slightly concave to point where abapical portion free

from base. Outer lip orthocline with distinct but small sinus adapically. No varix. Colour uniform dark reddish-brown, aperture yellow, with brown area on parietal part of inner lip.

Dimensions:	length	diameter
Holotype	2.10 mm	1.05 mm

Operculum — Typical.

Radula — Central teeth 2+1+2, median cusp long, with straight cutting edge, weakly serrated, about 1½ times width of adjacent cusps. Inner lateral cusps about 2/3 length of median cusp, sharp, outer lateral cusps about 1/3 length of inner lateral cusps (almost denticle-like). Lateral teeth 2+1+2, with inner edge bearing a weak denticle. Lateral cusps sharp, median cusps rather blunt, 1 1/3 length of adjacent cusps. Inner marginal teeth with about 10 sharp, small cusps. Outer marginals with about 8 sharp denticles.

LOCATION OF TYPE: T.M. Holotype (7737/E396, TM10885).

TYPE LOCALITY: Tamar Heads, Tasm., on rocks at low water.

ADDITIONAL MATERIAL EXAMINED: "Islands of Bass Strait", 2 lots (A.M.). Green Cape, Maria Is., E. Tasm., 6 m, 26 Mar. 1970, on sublittoral algae, coll. W. F. Ponder & D. C. Wolfe (A.M.). Pirates Bay, Eaglehawk Neck, S. Tasm., 31 Mar. 1970, on *Caulerpa;* brown algae; coralline algae; in beach sand, coll. W. F. Ponder (A.M.). Fossil Is., Eaglehawk Neck, S.E. Tasm., 3 June 1967, coll. A. J. Dartnall (T.M.). Wedge Bay, S. Tasm., 7 m, Voorwinde Coll. (A.M.). Dunally, S.E. Tasm., 30 June 1965, coll. L. Crofts & N. Patterson (T.M.). Tinderbox, S. Tasm., 12 Apr. 1967, coll. E. Aves (T.M.). Gordon, S. Tasm., 15 Apr. 1967, coll. A. J. Dartnall (T.M.). 3 km N. of Granville Harbour, W. Tasm., 23 Nov. 1967, coll. A. J. Dartnall (T.M.). Western Port, Vic. (N.M.V.). Flinders, Vic., ocean beach platform, on short algae, 16 Feb. 1969, coll. W. F. Ponder & B. J. Smith (A.M.). Portland, Vic., Gabriel Coll. (N.M.V.). Portsea, Vic. (N.M.V.). Lorne, Vic. (N.M.V.). Port MacDonnell, S.A., Verco Coll. (S.A.M.). Guichen Bay, S.A., Verco Coll. (S.A.M.). Robe, S.A., Verco Coll. (S.A.M.).

FOSSIL RECORD: Upper Pliocene: Cameron Inlet Formation, Hill's Dam at foot of Dutchman (E. side), Flinders Island, Nov. 1964, coll. T. A. Darragh (N.M.V.).

DISTRIBUTION AND HABITAT: Eastern South Australia, western Victoria, and Tasmania, from low tide to shallow sublittoral on algae (see fig. 17).

REMARKS: This species is distinguished by its squat, smooth shell and rather flat whorls. *P. frenchiensis* has a relatively longer spire and often has narrow colour bands which are never present in *dubitabilis.* The outer edge of the inner lip is straight or slightly convex in *frenchiensis*, never concave when mature as in *dubitabilis. P. megastoma* nov. has a similar outline to *P. dubitabilis* but has a relatively larger, more nearly circular aperture and more convex whorls. In addition the apertural lips are more expanded in *megastoma,* with the abapical portion of the inner lip more separated from the base than in *dubitabilis.* The radulae in the 3 species also show a number of differences.

Cotton's (1944) record of *dubitabilis* from "55 fathoms, Cape Borda, S.A." is based on one very worn specimen which is possibly this species but its identity is impossible to establish with certainty.

Pisinna flindersii (T. Woods). Fig. 5a.

Rissoina flindersii T. Woods, 1877b: 154.

Rissoia (Amphithalamus) flindersii.—May, 1903: 111, text fig. 8.

Amphithalamus flindersii.—Hedley, 1911: 106.

Estea flindersi.—May, 1921: 51; May, 1923: pl. 24, fig. 8.

Subestea flindersi.—Cotton, 1944: 292; Macpherson & Gabriel, 1962: 92.

DIAGNOSIS: Shell—Small, solid, with heavy axial folds and twice as many nodules abapical to sutures.

Protoconch—Typical, of 1½ whorls; faded to white in all available specimens.

Teleoconch—Spire outline very slightly convex, axial folds render sutures crenulate. 5 whorls, each slightly concave adapically, contracted to suture abapically. Sculpture of strong axial folds, rather irregular in shape, about 10 on penultimate whorl, with a row of smaller, weak to moderately strong, nodules abapical to sutures, these being twice as numerous as the axial folds. Folds subobsolete on last 1/3 of body whorl. Base convex. Aperture oval; inner lip rather thin, simple; outer lip thin, slightly produced ventrally in anterior section. Varix weak, broad. Colour yellowish-white to pale brown, axial folds paler than rest of shell (all specimens seen are faded).

Dimensions:	length	diameter
Figured syntype	3.45 mm	1.55 mm

LOCATION OF TYPES: Syntypes (3), T.M. (7747A/E406A, TM 5486).

TYPE LOCALITY: N.W. coast of Tasm., coll. W.F. Petterd.

ADDITIONAL MATERIAL EXAMINED: Largs Bay Jetty, S.A., Verco Coll. (S.A.M.). St. Vincent's Gulf, S.A., Verco Coll. (S.A.M.; N.M.V.). Sceale Bay, S.A., Verco Coll. (S.A.M.). S. of St. Francis Is., S.A., 64 m, Verco Coll. (A.M.; S.A.M.). The Heap, Tumby Bay, S.A., coll. J. Thompson, Voorwinde Coll. (A.M.). Great Aust. Bight, S.A., 33°05'S, 128°40'E, 75 m, 5 July 1962, H.M.A.S. "Gascoyne", stn G2/97/62 (A.M.). 80 km S.W. of Cape Adieu, Great Aust. Bight, S.A., 32°42'S, 131°27'E, ca. 79 m, 4 July 1962, H.M.A.S. "Gascoyne", stn G2/90/62 (A.M.).

DISTRIBUTION AND HABITAT: N.W. Tasmania to the Great Australian Bight (see fig. 16).

REMARKS: This species is easily recognised by its strong axial folds and row of nodules abapical to the suture, with the nodules twice as numerous as the folds.

Cotton (1944: 292) recorded *flindersi* from Hopetoun, W. Australia, but his specimens are not a species of *Pisinna*.

Pisinna frauenfeldi (Frauenfeld). Figs 4e-f; 13h.

Rissoa frauenfeldi Frauenfeld (from Schwartz v. Mohrenstern MS), 1867: 10, pl. 2, fig. 13; Weinkauff, 1885: 136, pl. 6, fig. 22, 23, 24; Tryon, 1887: 340, pl. 68, fig. 86; Tate, 1899: 232 (in part).

Rissoia frauenfeldi.—Angas, 1877: 187; Whitelegge, 1889: 104.

Rissoia (Amphithalamus) frauenfeldi (sic.). — Henn & Brazier, 1894: 174.

Amphithalamus frauenfeldi.—Hedley, 1911: 106.

Estea frauenfeldi.—Hedley, 1918:53.

Estea jervisensis Laseron, 1950: 269, fig. 34.

Estea narrabeenensis Laseron, 1950: 270, fig. 39.

Dardanula frauenfeldi.— Iredale & McMichael, 1962: 41.

Dardanula narrabeenensis.—Iredale & McMichael, 1962: 41.

Dardanula jervisensis.—Iredale & McMichael, 1962: 41.

DIAGNOSIS: Shell—Of rather large size for genus, solid, ovate-conical, with prominent axial ribs on all whorls and orange-brown and mottled white in colour.

Protoconch—Dome-shaped, orange-red, of 1½ whorls, sculptured with spiral rows of minute pits.

Teleoconch—Ovate-conical, spire slightly convex, whorls 3½-4, weakly to moderately convex, sutures incised. Axial ribs rounded, usually prominent but somewhat variable in strength; interstices about ½ width of ribs. Ribs present on all whorls but weak on first whorl and obsolete on last ¼ of body whorl; usually oblique (prosocline), especially on body whorl. Ribs fade on base and usually absent on abapical half of base. 24-26 ribs on penultimate whorl. Indistinct spiral scratches only other sculpture. Base very slightly convex. Aperture typical, rather large, outer lip slightly opisthocline or orthocline, inner lip separated from base abapically. A minute chink behind inner lip forms a false umbilicus. Varix absent. Colour rich golden-brown or orange-brown, with diffuse milky-white band (white coloration usually restricted to axial ribs alone) on middle or entire adapical half of body whorl, represented on spire whorls by a series of blotches adapical to sutures. Abapical part of whorls with a few white streaks and blotches, but these not present on base. Aperture and abapical base yellowish, adapical part of inner lip orange-brown.

Dimensions:	length	diameter
Lectotype	3.2 mm	1.5 mm
Lectotype of *narrabeenensis*	3.45	1.60
Lectotype of *jervisensis*	3.70	1.82

Operculum—Typical, muscle insertion area about 2/3 of surface area (fig. 13h).

Radula — Central teeth 2+1+2, middle cusp about twice width of adjacent cusps, outer cusps about ½ length of inner. Lateral teeth 2+1+5 (+denticle on inner side), main cusp about twice width of adjacent cusps, with bluntly rounded cutting edge. Inner marginal teeth with about 16-17 small, sharp cusps; outer marginal finely denticulate.

LOCATION OF TYPES: *Rissoa frauenfeldi* Naturhistorisches Museum, Vienna. Lectotype and 1 paralectotype (no number). Here chosen.

Estea jervisensis. A.M. Lectotype (C. 95570) and 18 paralectotypes (C. 95056). Here chosen.

Estea narrabeenensis. A.M. Lectotype (C. 95571) and 3 paralectotypes (C. 95057). Here chosen.

TYPE LOCALITIES. *Rissoa frauenfeldi*. "Sidney" (=Sydney, N.S.W.).

Estea jervisensis. Huskisson, Jervis Bay, N.S.W.

Estea narrabeenensis. Long Reef, Collaroy, N.S.W., under stones.

ADDITIONAL MATERIAL EXAMINED: Moreton Bay, S. Qld (A.M.). Off Flatrock, N. Stradbroke Is., S. Qld, 24-30 m, on algae, 2 Aug. 1971, coll. R. Ibara (A.M.). Yamba, N.S.W., coll. J. Kerslake (A.M.). Woolgoolga, N.S.W., coll. Poppins, Iredale Coll., 2 lots (A.M.). Off Port Stephens Lighthouse, N.S.W., 73 m, Voorwinde Coll. (A.M.). Off Port Stephens, N.S.W., 64 m, Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Lake Macquarie, N.S.W., coll. R. L. Cherry (A.M.). Catherine Hill Bay, near Swansea, N.S.W., coll. R. L. Cherry (A.M.). Pittwater, Broken Bay, N.S.W., Voorwinde Coll. (A.M.). Long Reef, Sydney, N.S.W.; on algae, Voorwinde Coll.; in 25 m, Laseron Coll. (A.M.). Narrabeen,

Sydney, N.S.W., Voorwinde Coll. (A.M.). North Harbour, Sydney, N.S.W., Voorwinde Coll. (A.M.). Balmoral, Sydney, N.S.W., 6-8 m; 11-15 m; 18 m; Voorwinde Coll. (A.M.). N. end of Balmoral Beach, Sydney, N.S.W., 2 m, 29 Jan. 1973, coll. W. F. Ponder, 2 lots (A.M.). Middle Harbour, Sydney, N.S.W., Voorwinde Coll.; coll. C. Hedley (A.M.). W. Channel, Port Jackson, Sydney, N.S.W., 27 m, Voorwinde Coll. (A.M.). Port Jackson, Sydney, N.S.W., dredged, Voorwinde Coll. (A.M.). Sydney Harbour, N.S.W., coll. A. U. Henn (A.M.). E. of Sydney, N.S.W., 150 m, 18 July 1962, H.M.A.S. "Gascoyne", stn G2/55-56/62 (A.M.). Little Coogee Bay, Sydney, N.S.W., Apr.-July, 1895, coll. J. Brazier, 3 lots (A.M.). Kurnell, Botany Bay, N.S.W., Voorwinde Coll. (A.M.). Bate Bay, Cronulla Beach, N.S.W., 30 April, 1893, coll. J. Brazier (A.M.). Gunnamatta Bay, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Cronulla, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Crookhaven, near Nowra, N.S.W., 55-64 m, Voorwinde Coll. (A.M.). Honeymoon Bay, Jervis Bay, N.S.W., lower littoral, 18 Jan. 1969, coll. W. F. Ponder (A.M.). Sussex Haven, N.S.W. (A.M.). S. side Ulladulla, N.S.W., outside breakwater on moderately exposed rock platform, on small brown algae and on coralline algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). S. side of Ulladulla, N.S.W., inside breakwater on sheltered reef, on small brown algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.). Batemans Bay, N.S.W., Voorwinde Coll. (A.M.). Merimbula Jetty, Merimbula, N.S.W., on exposed side under stones, 7 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Twofold Bay, N.S.W. (N.M.V.). Eden Harbour, N.S.W., dredged, Voorwinde Coll., 2 lots (A.M.). S.E.E. of Gabo Is., Mallacoota, Vic., 28 m, on algae in sponge bed; on red algae; Feb. 1973, coll. P. Hutchings (A.M.).

DISTRIBUTION AND HABITAT: South Queensland to Mallacoota, E. Victoria. On low tidal and sublittoral algae and beneath stones. Not uncommon (see fig. 18).

REMARKS: This is the largest of the axially ribbed species of *Pisinna*. *P. praecidecosta* (Ponder, 1965) from northern New Zealand is similar in size and shape but the axial ribs are terminated abruptly at the periphery and it is uniform brown in colour.

Estea narrabeenensis Laseron and *E. jervisensis* Laseron are both *frauenfeldi*, differing only slightly from one another. Laseron's (1950) concept of *frauenfeldi* is a sculptural form of *albizona* as shown above.

The type material consists of 2 syntypes both of which are *frauenfeldi*. The lectotype (here chosen) is the specimen figured in the original description of the species. It is a narrower shell than normal, the paralectotype being broader and more typical of the species. A third specimen (ex Mohrenstern Coll.) in the Naturhistorisches Museum, Vienna, is the ribbed form of *albizona*.

Pisinna frenchiensis (Gatliff & Gabriel). Figs 3e-h; 11e; 13g.

Rissoa cyclostoma T. Woods, 1877b: 152; Tate & May, 1901: 392; Pritchard & Gatliff, 1902: 104 (non *R. cyclostoma* Recluz, 1843).

Rissoia (Cingula) cyclostoma.—Tryon, 1887: 344 (the figure on pl. 71, fig. 8 is not this species).

Rissoia (Amphithalamus) cyclostoma.—Tate, 1899: 232.

Rissoa frenchiensis Gatliff & Gabriel, 1908: 379 (new name for *R. cyclostoma*, T. Woods).

Rissoa subfusca.—Gatliff & Gabriel, 1910: 94 (non Hutton, 1873).

Amphithalamus frenchiensis.—Hedley, 1911: 106.

Amphithalamus subfuscus.—Hedley, 1911: 108 (non Hutton, 1873).

Estea frenchiensis.—May, 1923: pl. 24, fig. 2; Cotton, 1944: 288.

Dardanula difficilis Gabriel, 1956: 7, fig. 5.

Pisinna frenchiensis.—Macpherson & Gabriel, 1962: 92.

Pisinna subfusca.—Macpherson & Gabriel, 1962: 92 (non Hutton, 1873).

DIAGNOSIS: Shell—Small, solid, pupoid, smooth; brown, often with narrow dark orange-brown spiral bands.

Protoconch—Dome-shaped, 1½ whorls, colour dark wine-red.

Teleoconch—Spire lightly convex to nearly flat; 3½-3¾ whorls, very weakly convex; sutures incised. Surface smooth except for growth lines, although these sometimes distinct. Base convex. Aperture subcircular, outer lip orthocline to opisthocline, slightly thickened within; inner lip well defined, abapical portion well separated from base. Varix moderate to absent. Spire dark purple-brown or dark red-brown in shallow-water shells, medium or yellow-brown on body whorl; sometimes with three narrow orange-brown bands, one abapical to the suture, other 2 on base. A broad yellowish or pale yellow-brown band sometimes present on the body whorl, this narrow on spire. Aperture yellowish-brown, darker on inner lip. Deep-water specimens yellow to white, usually with the 3 brown bands.

Dimensions:	length	diameter
Lectotype	2.85 mm	1.32 mm
Paratype of *Dardanula difficilis*	2.50	1.26
Figured specimen	2.64	1.32
Figured specimen (fossil specimen)	2.30	1.17

Operculum—Typical (fig. 13g).

Radula—Central teeth 2 + 1 + 2, with blunt, rather short median cusp, and short, sharp lateral cusps. Lateral teeth 2 + 1 + 3, inner edge with small denticle; median cusp blunt. Inner marginal teeth with 12 short cusps. Outer marginal teeth finely serrated (taken from small, uniformly brown specimen) (fig. 11e).

LOCATION OF TYPES: *Rissoa frenchiensis* T.M. Lectotype and paralectotype glued on tablet (7143/E12, TM 5475). Specimen here figured chosen as lectotype.

Dardanula difficilis. N.M.V. Holotype (F. 16129) and 4 paratypes (F. 16130). A.M. 1 paratype (C. 95048).

TYPE LOCALITIES: *Rissoa frenchiensis.* Long Bay, Tasm., coll. H. D. Atkinson.

Dardanula difficilis. On Bass Strait Cable between King Island and Stanley, Tasm. Probably near Elephant Shoal Reef, 7 km S.E. of King Is., Bass Strait (depth uncertain as it is not clear exactly where this material was collected).

ADDITIONAL MATERIAL EXAMINED: Elephant Shoal Reef, S.E. of King Is., Bass Strait, on Telecommunication Cable (N.M.V.). Frazer Bay, King Is., Tasm., 9-18 m, pres. F. Bassett Hull (A.M.). E. of Grassy, King Is., 58-77 m, 23 July 1962, H.M.A.S. "Gascoyne", stn G2/68-70/62, 2 lots (A.M.). Island of Bass Strait, coll. W. F. Petterd, 2 lots (A.M.). S.W. of West Point, N.W. Tasm., 41°09.2'S, 144°24.2'E, 88 m, 14 April 1973, B.M.R. stn 2121, M.T. "Sprightly", 2 lots (A.M.). Stanley, N. Tasm. (T.M.). Freestone Cove, Wynyard, N. Tasm., on algae, 12 Oct. 1971, coll. J. Beu (A.M.). Boat Harbour, N. Tasm., 31 Aug. 1969, coll. A. J. Dartnall (T.M.). West Head, Greens Beach, N. Tasm., under stones and on coralline algae, Mar. 1973, coll. R. Kershaw, 2 lots (A.M.). Badger Head, Tasm. (T.M.). Kelso, Tasm., Cox Coll., 2 lots (A.M.). 4 km N.E. of Beaching Bay, Maria Is., S.E. Tasm. 42°27.5'S, 148°12'E, 82 m, 25 Mar. 1970, coll. W. F. Ponder, F.R.V. "Penghana" (A.M.). Pirates Bay, Eaglehawk Neck, S. Tasm.,

on coralline algae; beach sand; on intertidal rocks, brown algae; under stones, 30-31 Mar. 1970, coll. W. F. Ponder, 3 lots (A.M.). Eaglehawk Neck, S. Tasm., pres. C. Hedley, 2 lots (A.M.). 11 km E. of Cape Pillar, S. Tasm., 182 m, pres. C. Hedley & W. L. May (A.M.). Wedge Bay, S. Tasm., 7 m, Voorwinde Coll., 2 lots (A.M.). S.W. approaches to Storm Bay, S.E. Tasm., H.M.A.S. "Moresby", Voorwinde Coll. (A.M.). Frederick Henry Bay, S. Tasm., W. L. May Coll. (T.M.). Browns River, Hobart, S. Tasm., pres. C. Hedley (A.M.). Tinderbox, Derwent Estuary, Tasm., 15 m, Voorwinde Coll. (A.M.). D'Entrecasteaux Channel, S., Tasm., 24 May 1965, H.M.A.S. "Moresby", Voorwinde Coll. (A.M.). D'Entrecasteaux Channel, S. Tasm., Killora Bay, towards jetty, 43°05'36"S, 147°19'12"E, 7.5 m, F.R.V. "Penghana", 23 Mar. 1970, coll. W. F. Ponder (A.M.). 3 km N. of Granville Harbour, W. Tasm., 23 Nov. 1967, coll. A. J. Dartnall (T.M.). Kilcunda, Vic., Gatliff Coll. (N.M.V.). Between Eagle & Crawfish Rocks, N.W. Arm, Western Port, Vic., 3-5 m, coll. W. F. Ponder & B. J. Smith, 2 lots (A.M.). Western Port, Vic., dredged, pres. J. C. Gabriel (A.M.). Flinders Ocean Beach platform, Vic., under stones, on algae, 4 May 1967, coll. B. J. Smith, 3 lots; 16 Feb. 1969, coll. W. F. Ponder & B. J. Smith (A.M.). Portsea, Vic., Gatliff Coll. (N.M.V., A.M.). MacDonnell Bay, S.A., Verco Coll. (S.A.M.). Port MacDonnell, S.A., Verco Coll. (S.A.M.). Off Beachport, E.S.A., 73 m, Verco Coll. (S.A.M.). W. of Cape Jaffa, E.S.A., 77 m, 25 July 1962, H.M.A.S. "Gascoyne", stn G2/76/62 (A.M.). Between Cape Jaffa and Kangaroo Is., S.A., 75-155 m, H.M.A.S. "Gascoyne", stns. G2/71, 72, 76, 77/62, 24-26 July 1962, 2 lots (A.M.). Normanville, S.A. (ex Tate Coll.), Verco Coll. (S.A.M.); Voorwinde Coll. (A.M.). Guichen Bay, S.A., Verco Coll. (S.A.M.). The Heap, Tumby Bay, S.A., coll. J. Thompson, Voorwinde Coll., 2 lots (A.M.). 64 km S. of Cape Wiles, S.A., 183 m, pres. Fisheries Bureau (A.M.). Waldergrave Is., W. side Eyre Peninsula, S.A., 1 m, on algae, 25 Oct. 1973, coll. S.A. Shepherd (A.M.). Mississippi Bay, 48 km E. of Esperance, S.W.A., on algae in 0-2 m, 6 Feb. 1972, coll. W. F. Ponder (A.M.).

FOSSIL RECORDS: Lower Miocene: Longfordian: Freestone Cove Sandstone (=lower bed), Table Cape (=Fossil Bluff), Tasm., Parr Coll.; Cudmore Coll. (N.M.V.). Table Cape, Tasm., coll. E. D. Atkinson (A.M.). Pliocene: Dry Creek Sands, Bore 41, St. James Park, hundred of Yatala, part section 413, 129 m (S. Aust. Dept. Mines). Bore 28, Woodville Gardens, hundred of Yatala, Sec. 425, 112 m (S. Aust. Dept. Mines). Bore 6, Hindmarsh, hundred of Yatala, Sec. 370, 132-148 m (S. Aust. Dept. Mines). Kalimnan: Grange Burn Formation, McDonald's Bank, Muddy Creek, Hamilton, Vic. (N.M.V.). Upper Pliocene: Cameron Inlet Formation, Hill's Dam at foot of Dutchman (E. side), Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.).

DISTRIBUTION AND HABITAT: Tasmania, Victoria W. of Wilsons Promontory, South Australia to Esperance in S.W. Australia, on algae and beneath stones in the lower littoral, sublittoral, and on the continental shelf (see fig. 19). Dead shells have been located as deep as 183 metres. Fossil specimens referred here to this species range from the Lower Miocene (fig. 3h).

REMARKS: Differs from *albizona,* which is the same size and shape, in usually not having a white band abapical to the sutures (although this is also occasionally absent in *albizona*). The yellowish band sometimes seen in *frenchiensis* is more diffuse and broader. In addition *albizona* frequently develops strong axial ribs, but these are always absent in *frenchiensis.* Whereas *albizona* is apparently restricted to the littoral and shallow sublittoral, *frenchiensis* is found on the continental shelf down to about 100 metres (although dead shells are located in deeper water).

Estea difficilis is the deep-water form of *frenchiensis* and is smaller and paler than shallow-water and littoral specimens. Shells of this form have relatively larger apertures and therefore straighter spire outlines (fig. 3e).

It is of interest to record that the authors of the name *frenchiensis* confused 4 species of *Pisinna* under that name, lots from Western Port including *approxima, oblata, frenchiensis* and *dubitabilis.*

The littoral form usually encountered differs from the more "typical", apparently often sublittoral form, in being smaller and uniformly dark reddish-brown. The lined form (fig. 3f.) only rarely occurs together in the same microhabitat with the small, uniformly coloured variety. It is possible that two species might eventually be recognised, although on shell characters it is very difficult to consistently separate these forms.

Although similar to, and sometimes confused with, the southern New Zealand species, *P. subfusca subfusca* (Hutton), *frenchiensis* is usually slightly smaller and narrower, darker in colour and has a consistently narrower inner lip which is less raised from the base. The New Zealand species also never develops colour bands.

Pisinna gradata sp. nov. Fig. 2c.

DIAGNOSIS: Shell—Minute, smooth, conical, with stepped whorls.

Protoconch—Dome-shaped, 1½-1¾ whorls, pinkish-yellow, with typical sculpture.

Teleoconch—Outlines convex with weakly to strongly stepped whorls, 3-31/3 in number. First whorl lightly concave, others lightly convex in paratypes, second concave in holotype. Sculpture very indistinct; oblique, fine, weak axial riblets on spire whorls becoming obsolete on body whorl. Riblets weakly crenulate, weak fold abapical to suture. Weak fold present on second whorl adapical to suture in holotype. Base convex, with a broad fold on abapical base. Aperture subcircular; inner lip broad, abapical portion considerably raised above base, outer lip slightly prosocline. Varix absent. Spire pinkish-red, body whorl and aperture yellowish-white (shell somewhat faded).

Dimensions:	length	diameter
Holotype	1.73 mm	0.84 mm

LOCATION OF TYPES: A.M. Holotype (C. 95027) and 2 paratypes (C. 95028).

TYPE LOCALITY: ca. 360 km E. of Newcastle, N.S.W., 33°04'S, 156°07'E, 230-275 m, B.M.R. stn 865, 21 Sept. 1969.

DISTRIBUTION AND HABITAT: Known only from the type locality, a seamount E. of Newcastle, N.S.W. (see fig. 20).

REMARKS: Although only the holotype and two rather worn paratypes are known, the new species is considered distinctive enough to warrant description. It is probably most closely related to *P. circumlabra* nov. but differs in its stepped sutures and ridge on the base.

Pisinna kershawi (T. Woods). Figs 4c-d.

Rissoina kershawi T. Woods, 1878: 57; Tryon, 1887: 392.

Rissoa olivacea.—Hedley, 1907: 288 (non Frauenfeld, 1867).

Amphithalamus kershawi.—Hedley, 1911: 107.

Estea kershawi.—May, 1920: 60, pl. 15, fig. 11; May, 1921: 51; Gatliff & Gabriel, 1922: 148 (in part); May, 1923: pl. 24, fig. 11; Cotton, 1944: 291; (?Cotton, 1952: 51).

Estea microcosta May, 1920: 61, pl. 15, fig. 12; May, 1921: 51; May, 1923: pl. 24, fig. 12; Cotton, 1944: 291.

Pisinna kershawi.—Macpherson & Gabriel, 1962: 92.

DIAGNOSIS: Shell—Small, solid, with close, oblique, simple axial ribs.

Protoconch—Dome-shaped of 1½ whorls, wine-red; sculpture typical.

Teleoconch—Outlines slightly convex, whorls 4, weakly convex. Sutures moderately impressed. Sculpture of moderate to strong, distinct, rounded, oblique (orthoclinal) ribs with subequal interspaces on all whorls. Ribs sometimes weak on first whorl, absent or subobsolete on last 1/4-1/3 whorl; and continue on to base. 28-48 ribs on penultimate whorl. Fine spiral scratches sometimes visible between ribs. Base convex. Aperture subcircular, thickened within; inner lip broad, outer lip very slightly opisthoclinal. Varix weak, broad. Colour pinkish-red, yellow or yellowish-white on abapical base and outer lip.

Dimensions:	length	diameter
Lectotype	2.58 mm	1.24 mm
Holotype of *Estea microcosta*	2.70	1.17

LOCATION OF TYPES: *Rissoina kershawi.* N.M.V. Lectotype (here chosen) and 3 paralectotypes (F. 654).

Estea microcosta. T.M. Holotype (7753/E412, C. 1701), A.M. paratype (C. 45958).

TYPE LOCALITIES: *Rissoina kershawi.* Long Bay, Tasm., coll. W. F. Petterd.

Estea microcosta. 11 km E. of Cape Pillar, S.E. Tasm., 183 m.

ADDITIONAL MATERIAL EXAMINED: Shelly Beach, Caloundra, S. Qld, Voorwinde Coll. (A.M.). N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll. (A.M.). Off Flatrock, N. Stradbroke Is., S. Qld, on algae, 24-30 m, 2 Aug. 1971, coll. R. Ibara (A.M.). Lake Macquarie, N.S.W., pres. R. L. Cherry (A.M.). Off Port Stephens, N.S.W., 73 m, from trawlers, sandy bottom, 1950-1960, Voorwinde Coll. (A.M.). Pittwater, Broken Bay, N.S.W., Voorwinde Coll. (A.M.). 35 km E. of Narrabeen, N.S.W., 146 m, pres. Prof. Haswell (A.M.). North Harbour, Sydney, N.S.W., Voorwinde Coll. (A.M.). Fairlight, Sydney, N.S.W., 5 m, Voorwinde Coll. (A.M.). Middle Harbour, Sydney, N.S.W., C. Hedley (A.M.). Chinamans Beach, Sydney, N.S.W., 3-7 m, Voorwinde Coll. (A.M.). Bottle and Glass Rocks, Sydney Harbour, N.S.W., 11 m; 17 m; Voorwinde Coll. (A.M.). Bottle and Glass Rocks, Sydney, N.S.W., 1878, coll. J. Brazier (A.M.). Port Jackson, Sydney, N.S.W., dredged, Hargraves Coll; Voorwinde Coll. (A.M.). Off Sydney, N.S.W., 55 m, Voorwinde Coll. (A.M.). Reclamation, Botany Bay, N.S.W., ex. C. Laseron Coll., Voorwinde Coll. (A.M.). Ocean Beach, Kurnell, Botany Bay, N.S.W., 1950-1960, Voorwinde Coll. (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.). S. of Ulladulla, N.S.W., inside Breakwater, sheltered reef, on small brown algae; outside breakwater on small brown algae and on coralline algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). 24 km off Twofold Bay, N.S.W., 37°26′S, 150°15′E, 75-154 m, 19 June 1962, H.M.A.S. "Gascoyne", stn G2/58-59/62 (A.M.). Eden Harbour, Twofold Bay, N.S.W., Voorwinde Coll. (A.M.). E. of Grassy, King Is., Bass Strait, 58-77 m, 23 July 1962, H.M.A.S. "Gascoyne", stn G2/68-70/62 (A.M.). Elephant Shoal Reef, S.E. of King Is., Bass Strait, on Telecommunication Cable (N.M.V.). Off S.W. of West Point, N.W. Tasm., 41°09.2′S, 144°24.2′E, 88 m, 14 April 1973, B.M.R. stn 2121, M.T. "Sprightly" (A.M.). Boat Harbour, N. Tasm., 31 Aug. 1969, coll. A. J. Dartnall (T.M.). Kelso, N. Tasm., ex Cox Coll. (A.M.). Off Waterhouse Point, N.E. Tasm., 40 m, 17 Jan. 1968, "Umitaka Maru" stns 68-30N, 68-31N, 68-32N, 3 lots (T.M.). 4 km N.E. of Beaching Bay, Maria Is., E. Tasm., 42°27.5′S, 148°12′E, 82 m, 25 Mar. 1970, coll. W. F. Ponder, F.R.V. "Penghana" (A.M.). Derwent Estuary, Tasm., Voorwinde Coll. (A.M.). Tinderbox, Derwent Estuary, Tasm., 15 m; 37 m, Voorwinde Coll. (A.M.). Killora Bay, D'Entrecasteaux Channel, S. Tasm., 24 April 1965, H.M.A.S. "Moresby", Voorwinde Coll. (A.M.). D'Entrecasteaux Channel, S. Tasm., towards jetty 43°05′36″S, 147°19′12″E, 7.5 m, 23 March 1970, F.R.V. "Penghana", coll. W. F. Ponder (A.M.). S.E.E. of Gabo Is., Vic., below lighthouse on algae and detritus, 15-18 m, Feb. 1973, coll. P.

Hutchings (A.M.). Between Cape Howe and Lakes Entrance, Vic., 37°55'S, 149°00'E, 75-78 m, 20 July 1962, H.M.A.S. "Gascoyne" stn G2/61/62 (A.M.). Off Wilsons Promontory, Vic., dredged, Gatliff Coll.; Gabriel Coll. (N.M.V.). San Remo, Vic., Voorwinde Coll. (A.M.). Between Eagle Rock and Crawfish Rock, N.W. Arm, Western Port Bay, Vic., 4-6 m, 15 Feb. 1969, coll. W. F. Ponder & B. J. Smith (A.M.). Western Port, Vic., 9 m, pres. J. C. Gatliff; pres. C. J. Gabriel (A.M.). Cowes, Vic., Robin Coll. (N.M.V.). Off Beachport, E.S.A., 365 m; 73 m, Verco Coll. (S.A.M.) (=Cotton's (1944) record of *microcosta*).

FOSSIL RECORDS: The writers have not examined any fossil specimens that can be referred to this species. Cotton (1952) has, however, recorded it from three localities but his specimens have not been examined.

DISTRIBUTION AND HABITAT: South Queensland to eastern South Australia. Living mostly in the shallow sublittoral, but sometimes found in the lower littoral in southern parts of its range (see fig. 16). Also found in deepwater (up to 365 metres) on the continental shelf.

REMARKS: The number of axial ribs is very variable and appears to increase with depth. The population on which *Estea microcosta* was based is from 183 m, and is here regarded as only a finely ribbed variety of *kershawi*. This species is most similar to *P. olivacea olivacea* (Frauenfeld) from which it is easily separated by the absence of a row of nodules abapical to the sutures and the axial ribs being present on all whorls.

The figured specimen is chosen as the lectotype and is taken from 4 here presumed to be the type series as they come from the type locality and were presented by the collector W. F. Petterd. May (1920: 60) notes that the types are in the "Melbourne Museum".

Pisinna laseroni sp. nov. Figs 2k-l.

DIAGNOSIS: Shell—Small, glossy, conical; short spired for genus with large aperture which has a prominent varix and reflected outer lip.

Protoconch—Dome-shaped, of 1½ whorls. Wine red, surface very minutely pitted.

Teleoconch—Spire outline almost flat; 3 whorls, lightly convex except for first whorl which is often slightly concave. Surface smooth and glossy. Base convex. Aperture large, subcircular; outer lip thin, slightly reflected, opisthocline. Inner lip rather thin, extending abaxially on parietal region in middle portion; a broad, shallow sinus formed in adapical and abapical corners of aperture. Varix very heavy, broad. Colour orange-pink, sutures margined on both sides with white or yellowish-white. Outer lip of aperture white.

Dimensions	length	diameter
Holotype	2.50 mm	1.22 mm

LOCATION OF TYPES: A.M. Holotype (C. 95029) and 7 paratypes (C. 95030).

TYPE LOCALITY: Off entrance to Port Stephens, N.S.W., 71 m, J. Voorwinde Coll.

ADDITIONAL MATERIAL EXAMINED: Off Sydney, N.S.W., 36 m, Voorwinde Coll. (A.M.). 35 km E. of Narrabeen, N.S.W., 146 m, coll. Haswell (A.M.). Off Port Kembla, N.S.W., 115-137 m, coll. C. Hedley (A.M.). 43 km S.E. of Cape Everard, E. Vic., 164-273 m, 9 May 1914 (A.M.).

DISTRIBUTION AND HABITAT: Port Stephens, N.S.W. to Cape Everard, Victoria on the continental shelf in 36-273 metres (see fig. 18).

REMARKS: This species is distinguished by its short, blunt spire, relatively large aperture and strong, prominent varix.

It is named for the late Mr. C. F. Laseron, who has been responsible for much of the recent work on minute Australian Mollusca.

Pisinna megastona sp. nov. Figs 2b; 11c; 13b.

DIAGNOSIS: Shell—Conical, with rapidly expanding whorls and large aperture. Surface smooth, colour dark purple-red or brown.

Protoconch—Dome-shaped, of 1½ convex whorls, with spiral rows of minute pits. Colour deep wine-red.

Teleoconch—Spire rather short, outline nearly straight. 2¾-3 moderately convex whorls. Surface smooth and shining, with very weak axial growth lines and subobsolete spiral striae. Base weakly convex, aperture large and expanded. Inner lip thin and narrow across parietal region, edge concave, expanded abapically. Outer lip orthoclinal or slightly prosoclinal. Varix absent. Colour dark purple-red to dark yellow-brown with pale yellow-brown aperture; edge of peristome darker brown. Inner lip at parietal region deep wine red to dark brown.

Dimensions:	length	diameter
Holotype	1.80 mm	1.00 mm

Operculum—Typical. The figure (fig. 13b) shows the outer layer partially separated from the inner layer.

Radula—Central teeth 2 + 1 + 2, with a small denticle on each side. Median cusp long, narrow, blunt, cutting edge with 2-4 denticles; lateral cusps rather long and sharp. Lateral teeth 3 + 1 + 3, inner edge with small denticle. Cusps narrow, long and sharp. Inner marginal teeth with 9 sharp cusps and a small denticle on outer edge. Outer marginals sharply denticulate (fig. 11c).

Headfoot—Typical of genus. Black dorsally, except for tentacles, which are unpigmented.

LOCATION OF TYPES: A.M. Holotype (C. 95031), 10 paratypes (C. 95032) and 15 paratypes (C. 95639).

TYPE LOCALITY: Pirates Bay, Eaglehawk Neck, S.E. Tasm., beneath stones (C.95031, 95032) and on brown algae (C. 95639) in the lower littoral, 30 Mar. 1970, coll. W. F. Ponder.

ADDITIONAL MATERIAL EXAMINED: Eaglehawk Neck, S.E. Tasm., 3 June 1967, coll. A. J. Dartnall (T.M.). 3 km N. of Granville Harbour, W. Tasm., 23 Nov. 1967, coll. A. J. Dartnall (1 specimen) (T.M.). Ocean side of Queenscliffe, Port Phillip, Vic., 13 Feb. 1969, under stones on rock platform, coll. W. F. Ponder (A.M.).

DISTRIBUTION AND HABITAT: S.E. and W. Tasmania, and W. Victoria, beneath stones and on algae on open coasts in the lower littoral. Infrequently collected (see fig. 17).

REMARKS: Similar to *frenchiensis* and *dubitabilis* but can be distinguished by its short, conical spire, convex whorls, large expanded aperture, and uniformly dark colour.

Four of the paratypes are heavily encrusted with a coralline growth.

Pisinna moretonensis sp. nov. Fig. 7a.

DIAGNOSIS: Shell—Large size for genus, solid, smooth, with irregular brown and white markings.

Protoconch—Dome-shaped, of 1½ whorls. Sculpture typical, colour pale brown.

Teleoconch—Spire weakly convex. Whorls 4½-5, very weakly convex; sutures impressed, the adapical edge of each whorl slightly stepped. Surface smooth, apart from very weak, irregular growth lines (the holotype has a slight peripheral groove at the

commencement of the body whorl but this is not typical of the species). Base convex; aperture circular, with internally thickened lips. Inner lip projects abaxially on to parietal region beyond remainder of aperture; outer lip opisthoclinal. Varix very broad but weak (stronger in holotype than in paratypes). Colour light purplish-brown on adapical part of spire, last two whorls yellowish or greyish-white with irregular orange or purplish-brown vertical blotches and streaks, very pale in the adapical 1/3 of whorls. Brown markings merge at periphery in a band, sharply cut off from the pale yellow-brown base. Sometimes a few brown streaks on base. Aperture yellowish-white except for a brown blotch on inner lip and sometimes 2 or 3 brown markings on outer lip.

Dimensions:	length	diameter
Holotype	5.40 mm	2.42 mm

LOCATION OF TYPES: A.M. Holotype (C. 95033), 7 paratypes (C. 95034), and 2 paratypes (C. 94991).

TYPE LOCALITY: N.E. of Cape Moreton Lighthouse, S. Qld, 115 m, Voorwinde Coll. (C. 95033, 95034); T.A. Garrard Coll. (C. 94991).

DISTRIBUTION AND HABITAT: Type locality only (see fig. 17).

REMARKS: This species differs from *P. paucirugosa* nov. in its larger size, smooth surface and colour pattern. *P. nitida* nov. is relatively more elongate, with a less evenly rounded body whorl and has a different colour pattern. This is the largest species of *Pisinna* yet recorded.

Pisinna nitida sp. nov. Figs 6h-i.

Rissoa bicolor.—Tate & May, 1901: 391, pl. 26, fig. 63; Pritchard & Gatliff, 1902: 103; Hedley, 1907: 288 (non Petterd, 1884).

Scrobs bicolor.—Hedley, 1903: 355 (in part) (non *bicolor* Petterd).

Estea bicolor.—Hedley, 1918: 53; May, 1921: 51 (in part); May, 1923: pl. 24, fig. 6; Cotton, 1944: 288 (in part); Laseron, 1950: 271, fig. 46; Iredale & McMichael, 1962: 41 (non *bicolor* Petterd).

DIAGNOSIS: Shell—Rather large for genus, with a tall, straight-sided spire; subangled to weakly angled periphery, almost flat whorls, surface shining, nearly smooth.

Protoconch—Dome-shaped, 1½-1¾ whorls, very close rows of exceedingly minute punctures, colour pale yellow-brown.

Teleoconch—Spire tall, straight-sided, periphery subangled to weakly angled. 4½-5 whorls, very lightly convex, almost flat. Surface superficially smooth but with variable, weak axial growth lines and microscopic spiral scratches. Base almost flat to lightly convex. Aperture obliquely oval, somewhat angled in abapical and adapical corners. Inner lip thick, advancing abaxially over middle section of parietal region; outer lip thickened within, orthoclinal or slightly opisthoclinal. Abapical section of inner lip sloping slightly abaperturally or horizontal with vertical axis of shell and therefore not much raised from base. Varix a broad, weak swelling; a minute false umbilical chink behind inner lip. Colour of spire purplish-brown when fresh, with a rather diffuse greyish-white band abapical to sutures. Body whorl yellow-brown, inner lip darker brown. Dead shells fade to orange-brown on the spire and eventually to yellow.

Dimensions:	length	diameter
Holotype	5.20 mm	2.08 mm
Paratype	4.40	1.84

LOCATION OF TYPES: A.M. Holotype (C. 95640) and 9 paratypes (C. 95052).

TYPE LOCALITY: Between Sydney Harbour Heads, N.S.W., in 27 m, sandy bottom, coll. C. F. Laseron.

ADDITIONAL MATERIAL EXAMINED: Caloundra, S. Qld, C. Hedley (A.M.). N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll. (A.M.). Woolgoolga, N.S.W., Poppins Coll. (A.M.). Manning River, N.S.W., 40 m (A.M.). Off Port Stephens, N.S.W., 91 m; 64 m, Voorwinde Coll. (A.M.). Pittwater, Broken Bay, N.S.W., dredged, Voorwinde Coll. (A.M.). 35 km E. of Narrabeen, N.S.W., 146 m, pres. Prof. Haswell (A.M.). Middle Harbour, Sydney, N.S.W., C. Hedley, (A.M.). Sow & Pigs Reef, Port Jackson, Sydney, N.S.W., 11-16 m, Voorwinde Coll. (A.M.). E. of Sydney, N.S.W., 150 m, 18 July, 1962, H.M.A.S. "Gascoyne", stn G2/55-56/62, 2 lots (A.M.). Off Sydney, N.S.W., trawled, Voorwinde Coll. (A.M.). Cronulla, N.S.W., Voorwinde Coll. (A.M.). Off Port Jibbon, N.S.W., 70 m, 3-7 July 1943, Iredale Coll. (A.M.). Crookhaven, N.S.W., 64 m, Voorwinde Coll. (A.M.). Moruya, N.S.W., 101 m, Iredale Coll. (A.M.). Off Picaninny Point, E. Tasm., 41°40'S, 148°18.4'E, 27 m, 24 Mar. 1973, coll. P. H. Colman, B.M.R. stn 2032 (A.M.). D'Entrecasteaux Channel, S. Tasm., Voorwinde Coll. (A.M.). Tasmania, pres. Miss Lodder (A.M.). Off Gabo Is., Vic., 14-27 m, coll. R. Bell, 2 lots (A.M.). Portsea, Vic., Gatliff Coll. (N.M.V.).

DISTRIBUTION AND HABITAT: South Queensland to Portsea, Victoria and Tasmania (see fig. 17). Probably restricted to soft (sandy) substrate in the sublittoral and on the continental shelf. Known depth range ?0-150 metres.

REMARKS: This is the species mistaken for *P. bicolor* by most authors, mainly due to Tate and May (1901) figuring this species as *Rissoa bicolor* (see remarks under *P. bicolor*). *P. nitida* differs from *P. bicolor* in having a much larger adult size, a subangled (fig. 6i) or angled (fig. 6h) periphery and a relatively smaller aperture. The abapical portion of the inner lip is horizontal to the vertical axis of the shell or it slopes slightly abaperturally as it meets the outer lip. This results in the abapical portion of the inner lip being less separated from the base than in *P. bicolor*. In addition the varix is relatively weaker and the outer lip is less strongly opisthocline than in *P. bicolor*.

Pisinna oblata (Laseron). Figs 6a-c.

Rissoa columnaria.—Gatliff & Gabriel, 1913b: 78 (non Hedley & May, 1908).

Scrobs oblata Laseron, 1956: 444, fig. 156.

DIAGNOSIS: Shell—Minute, pupoid, semi-opaque with relatively large aperture and fine axial ribs. Rather variable in size.

Protoconch—Dome-shaped, of 1½ whorls, sculptured with spiral rows of minute pits.

Teleoconch—Spire convex, of 3-3½ very weakly convex (almost flat), false margined whorls. Sculpture of numerous fine, rather weak axial riblets, slightly oblique (prosocline) on spire, strongly oblique on body whorl where the ribs are stronger. Base flat except for a weak basal bulge abapically. Aperture rather D-shaped, large, but does not protrude much beyond line of spire whorls. Inner lip rather narrow, abapical part sharply separated from base. Outer lip orthoclinal or slightly opisthoclinal. Varix rather distinct, close to edge of outer lip. Colour yellow in type (dead shell), deep reddish-purple in fresh shells due to inner shell layer showing through, body whorl and aperture yellowish-brown to white.

Dimensions:	length	diameter
Holotype	1.46 mm	0.67 mm
Bermagui, N.S.W.	1.55	0.68
Cronulla, N.S.W. (figured)	2.30	1.00

LOCATION OF TYPE: A.M. Holotype (C. 79574).

TYPE LOCALITY: Noosa Head, S. Qld, coll. Mrs. B. Page.

ADDITIONAL MATERIAL EXAMINED: Noosa Heads, S. Qld, Voorwinde Coll. (A.M.). N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll., 2 lots (A.M.). Off Crowdy Head, N.S.W., 32°38.9′S, 153°0.8′E, 91 m, 16 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll., 2 lots (A.M.). Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Off Port Stephens, N.S.W., dredged on sandy bottom, 64 m, Voorwinde Coll., 3 lots (A.M.). Off Laurieton, S. of Lake Macquarie, N.S.W., 73 m, Voorwinde Coll. (A.M.). Collaroy Beach, Sydney, N.S.W., Voorwinde Coll. (A.M.). Off Long Reef, Collaroy, Sydney, N.S.W. 25 m, C. F. Laseron Coll. (A.M.). Middle Harbour, Sydney, N.S.W. (A.M.). Chinamans Beach, Sydney, N.S.W., 4-7 m; 15 m, Voorwinde Coll., 4 lots (A.M.). Sow and Pigs Reef, Sydney, N.S.W. 11-16 m, Voorwinde Coll.; 9 Jan. 1879, coll. J. Brazier (A.M.). Port Jackson, Sydney, N.S.W., dredged, Voorwinde Coll. (A.M.). Cronulla, N.S.W., Voorwinde Coll. (A.M.). Ocean Beach, Kurnell, Botany Bay, N.S.W., 1950-1960, Voorwinde Coll. (A.M.). 26 km E. of Wollongong, N.S.W., 183 m (A.M.). Crookhaven Heads, N.S.W., 64 m, Voorwinde Coll. (A.M.). Batemans Bay, N.S.W., Voorwinde Coll. (A.M.). Wimbie Beach, Batemans Bay, N.S.W., under stones on fairly exposed rocks, 6 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Batemans Bay, N.S.W., Voorwinde Coll. (A.M.). Shelly Beach, Bermagui, N.S.W., Voorwinde Coll. (A.M.). W. of Grassy, King Is., Tasm., 58 m, Voorwinde Coll. (A.M.). Islands of Bass Strait, Petterd Coll. (A.M.). Off S.W. of West Point, N.W. Tasm., 41°09.2′S, 144°24.2′E, 88 m, 14 Apr. 1973, B.M.R. stn 2121, M.T. "Sprightly" (A.M.). D'Entrecasteaux Channel, S. Tasm., 24 Apr. 1965, H.M.A.S. "Moresby", Voorwinde Coll. (A.M.) (locality doubtful). Off Cape Pillar, Tasm., 183 m, May Coll. (S.A.M.). Port Albert, Vic., Worcester Coll. (N.M.V.). Off Wilsons Promontory, Vic., 2 lots (N.M.V.). Western Port, Vic. (A.M.); N.M.V.). Portsea, Vic., Gabriel Coll. (N.M.V.). Off Beachport, S.A., 73 m, Verco Coll., 4 lots (S.A.M.).

DISTRIBUTION AND HABITAT: South Queensland to W. Bass Strait and S.E. Tasmania (see fig. 19). Shallow sublittoral to 183 m.

REMARKS: Distinguished by its small size, fine, close-set, oblique axial ribs on the body whorl and convex spire outline. *P. columnaria* is similarly sculptured but evenly over the whole teleoconch, and has a much longer spire. Gatliff and Gabriel's records from off Wilsons Promontory, Victoria of *microcosta* (May) (1922: 148) and *columnaria* (1913b: 78) refer in part to this species and Cotton (1944) recorded it from off Beachport as "*Estea*" *janjucensis* (Gatliff & Gabriel).

This species is most similar to *Pisinna angustata* (Powell) from New Zealand, but the New Zealand species differs in its smaller size, narrower shell and relatively larger aperture.

There is considerable variation in size (cf. figs 6b, 6c), southern shells tending to be larger than those from the northern part of the range (including the holotype).

Pisinna olivacea olivacea (Frauenfeld). Figs 5c-e; 11f; 12c-f; 13c-d.

Alvania olivacea Frauenfeld, 1867: 11, pl. 2, fig. 14; Weinkauff, 1885: 183, pl. 24, fig. 4; Tryon, 1887: 339, pl. 66, fig. 43; Tate, 1899: 232; Kesteven, 1902: 206.

Alvania olivacea.—Angas, 1877: 187.

Rissoa diemenensis Petterd, 1884: 138; Tryon, 1887: 368.

Rissoa olivacea "Dunker".—Whitelegge, 1889: 266; Tate & May, 1901: 391; Pritchard & Gatliff, 1902: 103.

Rissoa (Amphithalamus) olivacea "Dunker".—Brazier, 1895: 696.

Amphithalamus olivacea.—Hedley, 1911: 107.

Estea olivacea.—Hedley, 1918: 53; may, 1921: 51; May, 1923: pl. 24, fig. 10; Cotton, 1944: 292; Laseron, 1950: 268; Ponder, 1965c: 137, pl. 21, fig. 4.

Estea olivacea "Dunker".—May, 1920: 60.

Dardanula olivacea.—Iredale & McMichael, 1962: 41.

Pisinna olivacea.—Macpherson & Gabriel, 1962: 92.

DIAGNOSIS: Shell—Small, rather variable, solid, conical to conico-pupoid, with moderately strong axial ribs and a single row of nodules abapical to sutures.

Protoconch—Dome-shaped, 1½ whorls, colour wine-red, yellow when faded. Sculptured with spiral rows of minute pits (fig. 12e-f).

Teleoconch—Spire lightly convex of about 31/3 lightly convex whorls. Axial ribs slightly oblique, variable in strength, usually subobsolete on last 1/3 of body whorl. First whorl of teleoconch with very weak axial threads or riblets, weak ribs on second whorl. A distinct furrow separates a row of nodules abapical to sutures and occasionally, a second, weaker row is present abapical to this. Nodules very variable in strength. Occasionally a weak, central, spiral depression present on body whorl. Periphery rounded to subangled, base lightly convex. Aperture rather large, varying from almost circular to D-shaped. Edges of lips thin and almost orthoclinal. Varix absent; colour red-brown, orange-red or orange-brown, often with sutural row of nodules white (as in lectotype). Sublittoral specimens tend to be unicoloured and paler than littoral specimens. Aperture yellowish, parietal area brown in dark-coloured specimens. Spire frequently dark red due to inner shell layer.

Dimensions:	length	diameter
Lectotype	2.00 mm	1.05 mm
Lectotype of *Rissoa diemenensis*	2.15	1.08
Paralectotype of *R. diemenensis*	2.30	1.10
Figured specimens	2.15	1.15
	1.72	0.93

Operculum—Typical (fig. 13c-d).

Radula—Central teeth 1+1+1 (+rather prominent denticle on outer edges), middle cusp about same to almost twice width of adjacent cusp, but with blunt cutting edge broken up into 2 or 3 minute serrations. Lateral teeth 2+1+3, with minute denticle on inner edge; main cusp rather blunt, about twice width of adjacent cusps. Inner marginal teeth with about 13-14 small, sharp cusps, outer marginals with about 12 denticles (fig. 11f).

LOCATION OF TYPES: *Alvania olivacea.* Naturhistorisches Museum, Vienna. 4 lots of syntypes (Sydney, Botany Bay, Bondi, and Sydney ex Mohrenstern Coll.). 3 lots contain many specimens and 1 (Bondi) contains 3 specimens (no numbers). A lectotype (Botany Bay) (here chosen) has been segregated.

Rissoa diemenensis. T.M. Lectotype and paralectotype (7145/E14, TM 5486, C268).

TYPE LOCALITIES: *Alvania olivacea.* See above. All Sydney area, N.S.W.

Rissoa diemenensis. "Table Cape and Tamar Heads", Tasm.

ADDITIONAL MATERIAL EXAMINED: Noosa Heads, S. Qld, J. Voorwinde Coll. (A.M.) (identification uncertain). N.E. of Cape Moreton Light, S. Qld, J. Voorwinde Coll. (A.M.). Sandgate, Moreton Bay, S. Qld, 2 lots (A.M.). S.W. of Solitary Is., N.S.W., 15 m, on

small boulder, 17 May 1972, coll. P. Hutchings & P. Weate (A.M.). Bellingen River, N.S.W., J. Voorwinde Coll. (A.M.). Off Crowdy Head, N.S.W., 32°38.9'S, 153°08'E, 91 m. 16 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Off Point Halliday, N.S.W., 32°06'S, 152°54.2'E, 118 m, 5 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Off Forster, N.S.W., 32°11.2'S, 152°54.2'E, 117 m, Dec. 1957, H.M.A.S. "Warrego" (A.M.). Off Sugarloaf Point, N.S.W., 32°18'S, 152°50'E, 113 m, Dec. 1957, H.M.A.S. "Warrego" (A.M.). Port Stephens, N.S.W., dredged 1950-60, Voorwinde Coll., 2 lots (A.M.). Off Lighthouse, Port Stephens, N.S.W., 73 m, Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Seal Rocks, N. of Newcastle, N.S.W., Voorwinde Coll. (A.M.). Pittwater, Broken Bay, N.S.W., Voorwinde Coll., 2 lots (A.M.). Long Reef, Sydney, N.S.W., Voorwinde Coll., 4 lots (A.M.). Narrabeen, Sydney, N.S.W., dredged, Voorwinde Coll., 3 lots (A.M.). 5 km E. of Long Point, Sydney, N.S.W., 39 m, rocky bottom, 14 Apr. 1972, coll. Shelf Benthic Survey (A.M.). Fairlight, Sydney Harbour, N.S.W., on mixed short algae, low tide, 23 Dec. 1968, coll. W. F. Ponder (A.M.). Fairlight, Sydney Harbour, N.S.W. (3 lots); *Zonaris* wash (2 lots); 4-6 m (1 lot), Voorwinde Coll. (A.M.). Little Manly Cove, Port Jackson, Sydney, N.S.W., 13 Sep. 1894, coll. J. Brazier (A.M.). North Harbour, Sydney, N.S.W., Voorwinde Coll., 3 lots (A.M.). Balmoral, Sydney, N.S.W., 18 m; 11-14 m, Voorwinde Coll. (2 lots); on brown algae, 19 Jan. 1969, coll. W. F. Ponder & J. Voorwinde (A.M.). Middle Harbour, Sydney, N.S.W., 5 m, Voorwinde Coll.; coll. C. Hedley (A.M.). Chinamans Beach, Sydney, N.S.W., 3-7 m, Voorwinde Coll. (A.M.). Ny-ar-gine Point, Sydney, N.S.W., 19 Dec. 1968, coll. A.M. party (A.M.). Bottle and Glass Rocks, Sydney, N.S.W., 9 Oct. 1968, coll. W. F. Ponder (A.M.). Off Bottle and Glass Rocks, Sydney, N.S.W., 9 m, 1878, coll. J. Brazier (A.M.). Sow and Pigs Reef, Sydney, N.S.W., 9 m, Voorwinde Coll., 2 lots (A.M.). E. side of Sow and Pigs Reef, Port Jackson, N.S.W., near the rocks, rocky bottom, 1865, coll. J. Brazier (A.M.). Little Coogee Bay, Sydney, N.S.W., rock pools, 13 July 1895; 21 Apr. 1895, coll. J. Brazier, 5 lots (A.M.). Off Sydney, N.S.W., trawled in 37 m, Voorwinde Coll. (A.M.). Kurnell, Botany Bay, N.S.W., Voorwinde Coll. (A.M.). Gunnamatta Bay, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Port Kembla, N.S.W., 115-137 m (A.M.). Honeymoon Beach, Jervis Bay, N.S.W., under stones in lower littoral; beach sand; 18 Jan. 1969, coll. W. F. Ponder & N. Coleman (A.M.). Wreck Bay, N.S.W., C. Hedley (A.M.). Ulladulla, southern N.S.W., Voorwinde Coll. (A.M.). S. side of Ulladulla, N.S.W., inside breakwater on sheltered reef on small brown algae; on coralline algae; 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). S. side of Ulladulla, N.S.W., outside breakwater, on moderately exposed rock platform, on small brown algae; on coralline algae; 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Batemans Bay, N.S.W., Voorwinde Coll., 3 lots (A.M.). Lake at Merimbula, N.S.W., Voorwinde Coll. (A.M.). Merimbula Jetty, Merimbula, N.S.W., on exposed side, under stones, 7 Jan. 1970, coll. W. F. Ponder & P. H. Colman, 3 lots (A.M.). Twofold Bay, N.S.W., C. Hedley (A.M.). Badger Head, N. Tasm. (T.M.). West Head, Greens Beach, N. Tasm., under stones and on coralline algae, Mar. 1973, coll. R. Kershaw (A.M.). Kelso, Tamar River, N. Tasm., Cox Coll. (A.M.); W. L. May Coll. (T.M.). Off Waterhouse Point, N.E. Tasm., ca. 40 m, 17 Jan. 1968, "Umitaka Maru" Stn. 68-30 N, 68-31 N, 68-32 N (3 lots) (T.M.). Tinderbox, S. Tasm., 12 Apr. 1967, coll. E. Aves (T.M.). Pirates Bay, Eaglehawk Neck, S.E. Tasm., under stones, lower littoral, 30 Mar.-2 Apr. 1970, coll. W. F. Ponder (A.M.). Pirates Bay, Eaglehawk Neck, S.E. Tasm., C. Hedley (A.M.). Derwent River, Tasm., W. L. May (A.M.). Derwent River Estuary, Tasm., Voorwinde Coll. (A.M.). S.S.E. side of Gabo Is., E. Vic., 28 m, on red algae, Feb. 1973, coll. P. Hutchings, 2 lots (A.M.). Monumental Bay, Gabo Is., E. Vic., 15-18 m, on boulder fauna, Feb. 1973, coll. P. Hutchings (A.M.). S.E. side of Gabo Is., E. Vic., 28 m, in sponge bed, Feb. 1973, coll. P. Hutchings (A.M.). S.S.E. side of Gabo Is., E. Vic., below lighthouse, 15-18 m, on algae and in detritus, Feb. 1973, coll. P. Hutchings (A.M.). Gabo Is., S. of Cape Howe, Vic., 26 m, coll. R. Bell (A.M.). Upper San Remo, Vic., dredged in 5-7 m, Voorwinde Coll. (A.M.). Kilcunda, Vic., Gatliff Coll. (N.M.V.). Shoreham, Western Port, Vic., Gatliff Coll. (N.M.V.). Flinders, Western Port, Vic., shell sand, Voorwinde Coll. (A.M.). Flinders Ocean Platform, Vic., on short algae, low tide, 16 Feb. 1969, coll. W. F. Ponder & B. J. Smith (A.M.). Between Eagle Rock and Crawfish Rock, N.W. Arm, Western Port, Vic., 3-5 m, 15 Feb. 1969, coll. W. F. Ponder & B. J. Smith (A.M.).

DISTRIBUTION AND HABITAT: South Queensland to E. Victoria and N. and S. Tasmania (see fig. 16). This species is very abundant in N.S.W., but rather uncommon in the other parts of its range. It lives in the middle to lower littoral and shallow sublittoral on short algae and beneath stones etc. Specimens dredged on the continental shelf are all dead shells and are probably Holocene or Pleistocene fossils from fossil shore lines.

REMARKS: The sculpture of *olivacea olivacea* and *castella* is very similar, *olivacea olivacea* sometimes producing all of the elements seen in *castella* with three incipient rows of nodules. The difference is mainly one of degree and, although it is possible that they are but sculptural forms of a single species, this is thought to be unlikely.

Two forms of *P. olivacea olivacea* can sometimes be distinguished. A dark-coloured form with a white band across the strong sutural row of nodules (fig. 5c) contrasts markedly with a smaller, paler, uniformly coloured form which often has a weaker row of sutural nodules (Fig. 5d). The two forms, however, are frequently encountered in the same samples and intermediates are common.

The New Zealand counterpart of this species is *P. impressa* (Hutton, 1885) (see Ponder, 1965c: 136). Australian and New Zealand specimens are hardly separable and it is probable that they are conspecific. The New Zealand specimens usually have strong axial ribs extending over all whorls of the teleoconch and for this reason they are here considered to be subspecifically distinct from *olivacea olivacea* which usually has no axials or only weak ribs on the first whorl of the teleoconch.

A very beach worn series of 8 specimens from Noosa Heads is referred to this species with some doubt. In some respects these shells resemble miniature forms of *P. tumida simplicosta* nov., to which a further 5 larger specimens from the same sample are tentatively referred.

Hedley's (1905, 1907) deep-water N.S.W. records of this species refer to *P. tumida simplicosta* and *P. kershawi* respectively.

Pisinna paucirugosa sp. nov. Fig. 7h.

Scrobs bicolor.—Hedley, 1903: 355 (in part) (non Petterd, 1884).

DIAGNOSIS: Shell—Moderately large for genus, pupoid, very solid, with dull surface and very fine, weak, blunt axial threads.

Protoconch—Typical, dome-shaped, of 1½ whorls.

Teleoconch—Spire outline slightly to moderately convex, whorls 4¼-4½, slightly convex. Sutures impressed, sometimes very slightly stepped, and occasionally narrowly caniculate. Weak, close, oblique, blunt riblets on all whorls, sometimes very indistinct. Base convex; aperture subcircular, heavily thickened within. Outer lip slightly opisthocline; varix very weak, broad. Colour reddish-purple, fading to purplish-grey or grey with a broad white band abapical to the sutures, the abapical edge of which is rather diffuse. Base and aperture yellowish-white or white, a pale purplish-red patch on inner lip.

Dimensions:	length	diameter
Holotype	4.40 mm	2.00 mm

LOCATION OF TYPES: A.M. Holotype (C. 95035) and 16 paratypes (C. 95036).

TYPE LOCALITY: 115 m, N.E. of Cape Moreton Lighthouse, S. Qld, J. Voorwinde Coll.

ADDITIONAL MATERIAL EXAMINED: Off Cape Moreton, Qld, 115 m, T. A. Garrard Coll. (A.M.). Off Manning River, N.S.W., 40 m (A.M.). Off Laurieton, N. of Taree, N.S.W.,

73 m, Voorwinde Coll. (A.M.). Off Soldiers Point, Port Stephens, N.S.W., 20 m, Voorwinde Coll. (A.M.). Off Norah Head, near the Entrance, N.S.W., 45-55 m, Coll. McNeill & Livingstone (A.M.). Off Broughton Island, Port Stephens, N.S.W., coll. J. Brazier. (A.M.). Newcastle Bight, N.S.W., 45-50 m (A.M.). E. of Sydney, N.S.W., 150 m, 18 July 1962, H.M.A.S. "Gascoyne", stn G2/55-56/62 (A.M.). Off Sydney, N.S.W., trawled, J. Voorwinde Coll. (A.M.). Off Crookhaven Heads, N.S.W., 64 m, J. Voorwinde Coll. (A.M.). Off Moruya, N.S.W., 101 m, T. Iredale Coll. (A.M.).

FOSSIL RECORD: Cheltenhamian: Black Rock Sands, shell band above nodule bed, Beaumaris, Vic., Cudmore Coll. (N.M.V.) (1 specimen).

DISTRIBUTION AND HABITAT: South Queensland to at least as far as Moruya, southern N.S.W. on the continental shelf from 20-150 metres (see fig. 15).

REMARKS: Similar in size to *P. nitida* nov. but differs in its more ovate shell, weak axial rugae and in other details. It is of similar size to *P. varicifera relata* (Cotton) from which it differs in its heavier, more compact shell, less distinctly caniculate sutures and different style of axial ornament, the axials being thin and sharp in *varicifera relata*. *P. paucirugosa* is sympatric with *P. moretonensis* in the type locality of the latter, from which it differs in its slightly smaller size, presence of axial sculpture, and in the details of colour.

Two juveniles from 31-37 m, Masthead Island, Capricorn Group, Qld (A.M.) appear to be this species but adult specimens are needed for confirmation.

Pisinna salebrosa (Frauenfeld). Fig. 5b.

Alvania salebrosa Frauenfeld, 1867: 11, pl. 2, fig. 15.

Rissoa salebrosa.—Weinkauff, 1885: 183, pl. 24, figs 5, 6; Tryon, 1887: 327, pl. 66, fig. 44; Henn & Brazier, 1894: 173; Whitelegge, 1889: 266; Kesteven, 1902: 206; Pritchard & Gatliff, 1902: 102.

Alvania salebrosa "Dunker".—Angas, 1877: 187.

Rissoa salebrosa "Dunker".—Tate, 1899: 232.

Scrobs salebrosus.—Hedley, 1903: 355.

Amphithalamus salebrosus.—Hedley, 1911: 108.

Estea salebrosa.—Hedley, 1918: 53; Laseron, 1950: 269, fig. 33.

Subestea salebrosa.—Cotton, 1944: 291; Macpherson & Gabriel, 1962: 92.

Feldestea salebrosa.—Iredale, 1955: 81.

Dardanula salebrosa.—Iredale & McMichael, 1962: 41.

DIAGNOSIS: Shell—Small, solid, broadly conical, with short spire, angled periphery and median indentation on the axially ribbed body whorl.

Protoconch—Conico-dome shaped. Colour wine-red, fades to yellow-brown or yellow.

Teleoconch—Spire outline conical, slightly convex, spire whorls very weakly convex. 3 1/3-3 3/4 whorls: first 1 1/2 (approx.) with extremely weak axial riblets or threads. Penultimate whorl and body whorl with stout, orthocline ribs, rounded in section with interspaces of about equal width; 12-14 on body whorl usually becoming obsolete on last 1/4 whorl. A weak depression on centre of body whorl, commencing on last 1/4 of penultimate whorl; axial ribs narrower over depressed area, thickened adapically and abapically. Ribs continue across periphery, but are weak or absent on base. Base almost flat;

at about 45° to adapical part of the whorl. Periphery distinctly angled. Aperture oval, with peristome somewhat D-shaped; inner lip rather thin and straight, abapical portion well separated from base; outer lip orthocline, thin-edged, thickened within. Varix absent. Colour dark orange-brown fading to yellowish-orange. Adapical part of spire deep purplish; aperture yellow-brown to pale yellowish with a brown parietal region.

Dimensions	length	diameter
Syntype (from original description)	3.2 mm	1.5 mm
Figured specimen	2.40	1.40

LOCATION OF TYPES: Naturhistorisches Museum, Vienna (no number) 3 lots. No lectotype was designated as all specimens in the type series were *P. salebrosa* and showed little variation.

TYPE LOCALITIES: "Sidney" (=Sydney) (6 specimens+4 ex Mohrenstern Coll.) and Botany Bay (5 specimens), N.S.W.

ADDITIONAL MATERIAL EXAMINED: N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll. (A.M.). Off Moreton Bat, S. Qld, 27°31'S, 153°40'E, 75-85 m, H.M.A.S. "Kimbla", 29 Mar. 1969, coll. W. F. Ponder (A.M.). Off Flatrock, N. Stradbroke Is., S. Qld, 24-30 m, on algae, 2 Aug. 1971, coll. R. Ibara (A.M.). Port Macquarie, N.S.W., 183 m, C. Hedley (A.M.). Lighthouse, Port Stephens, N.S.W., 73 m, Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Port Stephens, N.S.W. (A.M.). Reclamations, Bayview, Pittwater, N.S.W., C. Laseron Coll. (A.M.). Narrabeen, Sydney, N.S.W., Voorwinde Coll. (A.M.). Long Reef, north side, Sydney, N.S.W., Voorwinde Coll. (A.M.). S. side of Long Reef, Sydney, N.S.W., on short, brown algae, 16 June 1969, Coll. W. F. Ponder & P. H. Colman (A.M.). Little Fairlight, Sydney, N.S.W., Voorwinde Coll. (A.M.). Balmoral, Sydney, N.S.W., 11-15 m, Voorwinde Coll. (A.M.). Middle Harbour, Sydney, N.S.W., Voorwinde Coll.; C. Hedley (A.M.). Chinamans Beach, Sydney, N.S.W., 3-7 m, Voorwinde Coll. (A.M.). Bottle and Glass Rocks, Sydney, N.S.W., 9 m, 1878, coll. J. Brazier; lower littoral, 9 Oct. 1968, coll. W. F. Ponder (A.M.). Off Green Point, Watsons Bay, Port Jackson, Sydney, N.S.W., 7 m, June 1868, coll. J. Brazier (A.M.). Sow and Pigs Reef, E. side, Sydney, N.S.W., 3 m, 1865, coll. J. Brazier (A.M.). Port Jackson, Sydney, N.S.W., dredged, Voorwinde Coll., 2 lots (A.M.). Port Jackson, Sydney, N.S.W., Hargraves Coll. (A.M.). Sydney Harbour, N.S.W., coll. A. U. Henn (A.M.). Little Coogee Bay, Sydney, N.S.W., July 1895, coll. J. Brazier (A.M.). Kurnell, Botany Bay, N.S.W., Voorwinde Coll. (A.M.). Gunnamatta Bay, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.).

DISTRIBUTION AND HABITAT: This species extends from at least south Queensland to Ulladulla, N.S.W. (see fig. 19). It is uncommon over most of its range and, although sometimes found alive in the lower littoral, it is presumed to prefer a sublittoral habitat as most of the specimens available are dead shells from beach drift. The records from the continental shelf are almost certainly fossil shells from Pleistocene or Holocene shore lines.

REMARKS: This species is readily distinguished by its broadly conical shell, and ribbed, centrally depressed body whorl.

Pisinna tasmanica (T. Woods). Figs 6d-f.

Eulima tasmanica.—T. Woods, 1876a: 29; Tryon, 1886: 278.

Rissoa tasmanica.—Tate, 1899: 233; Pritchard & Gatliff, 1902: 108.

Rissoa tasmanica.—May, 1903: 110, text fig. 6.

Amphithalamus tasmanicus.—Hedley, 1911: 108.

Rissoa bicolor.—Gatliff & Gabriel, 1913a: 69, pl. 8, figs 5, 6 (non Petterd, 1884).

Estea tasmanica.—May, 1921: 52; May, 1923: pl. 24, fig. 3; Cotton, 1944: 290; Laseron, 1950: 269; Iredale & McMichael, 1962: 41.

Pisinna tasmanica.—Macpherson & Gabriel, 1962: 92.

DIAGNOSIS: Shell—Small, narrowly conical, smooth, shining; body whorl sometimes with axial riblets or ribs.

Protoconch—Typical, of 1½-1¾ whorls, orange-red.

Teleoconch—Spire outline very slightly convex, almost straight; of 3½-4 whorls, very slightly convex, sutures distinct, impressed on last whorl. Smooth except for extremely fine axial growth threads and occasional spiral scratches, body whorl often with close axial riblets or ribs, sometimes very weak. Subangled to rounded periphery, base weakly convex to almost flat. Aperture nearly circular, slightly contracted, the lips thickened within. Inner lip somewhat advanced abaxially over parietal region, free portion considerably separated from base, usually with a shallow chink behind; outer lip with edge almost orthocline. Varix very weak or absent. Colour white, yellowish, or yellowish-brown with the wine-red or purple inner layer showing through shell, especially on the spire. Aperture white, shallow-water shells sometimes have pale yellowish-brown inner lip.

Dimensions:	length	diameter
Holotype	2.60 mm	1.15 mm
Figured specimens	2.56	1.14
	2.34	1.10

LOCATION OF TYPE: T.M. Holotype (7762/E421, TM5428).

TYPE LOCALITY: Long Bay, Tasm., 11 m.

ADDITIONAL MATERIAL EXAMINED: N.E. of Cape Moreton, S. Qld, 128-182 m, Voorwinde Coll. (A.M.). Trawled N.E. of Cape Moreton Light, S. Qld, 115 m, Voorwinde Coll. (A.M.). Moreton Bay, S. Qld, C. Hedley (A.M.). Off Laurieton, N.S.W., 55 m, Voorwinde Coll. (A.M.). Off lighthouse, Port Stephens, N.S.W., 73 m, Voorwinde Coll. (A.M.). Soldiers Point, Port Stephens, N.S.W., 18 m, Voorwinde Coll. (A.M.). Port Stephens, N.S.W., trawled, Voorwinde Coll. (A.M.). Cape Three Points, near Tuggerah Lakes, N.S.W., 75-91 m (A.M.). Off Broken Bay, N.S.W., 137 m, Voorwinde Coll. (A.M.). Port Jackson, Sydney, N.S.W., 46 m, Voorwinde Coll. (A.M.). Off Sydney, N.S.W., 82 m, Voorwinde Coll. (A.M.). E. of Sydney, N.S.W., 150 m, 18 July 1962, H.M.A.S. "Gascoyne", stn G2/56/62, 3 lots (A.M.). Sydney, N.S.W., trawled, Voorwinde Coll. (A.M.). Off Botany Bay, Sydney, N.S.W., 110 m, Voorwinde Coll. (A.M.). 29 km E. of Malabar, Sydney, N.S.W., 192-203 m, stn 43, 9 Aug. 1973, coll. Shelf Benthic Survey (A.M.). Jibbon, near Cronulla, N.S.W., 80 m, 9 Jan. 1964, Voorwinde Coll. (A.M.). Off Cronulla, N.S.W., 46 m, Voorwinde Coll. (A.M.). Off Port Kembla, N.S.W., 115-137 m, C. Hedley (A.M.). Off Crookhaven, N.S.W., 55-64 m, Voorwinde Coll. (2 lots); Laseron Coll. (A.M.). 40 km E. of Twofold Bay, N.S.W., 37°27′S, 150°17′E, 294-304 m, 19 June 1962, H.M.A.S. "Gascoyne", stn G2/60/62 (A.M.). 24 km off Twofold Bay, N.S.W., approx 37°26′S, 150°15′E, 75-154 m, 19 June 1962, H.M.A.S. "Gascoyne", stn G2/58-59/62 (A.M.). 32 km S.E. of Twofold Bay, N.S.W., 37°26′S, 150°15′E, 149 m, H.M.A.S. "Gascoyne", stn G2/59/62, 19 June 1962 (A.M.). Elephant Shoal Reef, S.E. of King Is., Bass Strait, on Telecommunication Cable (N.M.V.). Off Devonport and Launceston, Tasmania, Voorwinde Coll. (A.M.). Off Cape Naturaliste, N.E. Tasm., 40°50.6′S, 148°46.5′E, 399 m, 26 Mar. 1973, M.T. "Sprightly", stn 2051, coll. P. H. Colman (A.M.). Off Piccaninny Point, N. of Bicheno, E. Tasm., 41°40′S, 148°18.4′E, 27 m, 24 Mar. 1973, M.V. "Sprightly", stn 2032, coll. P. H. Colman (A.M.). Marion Bay, S. of Maria Island, S.E. Tasm., 42°50′S, 147°59.8′E, 58 m, 13

Mar. 1973, M.T. "Sprightly", stn 1993, coll. P. H. Colman (A.M.). Port Arthur, S. Tasm., May Coll. (S.A.M.). Derwent Estuary, S. Tasm., Voorwinde Coll. (A.M.). Tinderbox, Derwent Estuary, S. Tasm., 15 m, Voorwinde Coll. (A.M.). Storm Bay, S. Tasm., H.M.A.S. "Moresby", Voorwinde Coll. (A.M.). 17 km S.W. of Cape Raoul, S. Tasm., 43°25'S, 147°45'E, 117 m, 24 Mar. 1970, F.R.V. "Penghana", coll. W. F. Ponder (A.M.). Off Cape Everard, Vic., 128-146 m, T. Iredale Coll. (A.M.). 57 km S. of Cape Conran, off Gippsland, Vic., 38°18.20'S, 148°40'E, 218-264 m, "Esso-Gipps" stn 10, May 1969, coll. C. Phipps (A.M.). 113 km S. of Lakes Entrance, Vic., 39°00'S, 148°24.50'E, 95 m, sand, May 1969, "Esso-Gipps" stn 20, coll. C. Phipps (A.M.). Off 90 Mile Beach, Vic. (N.M.V.). 29 km S. by S.E. of Lakes Entrance, Vic., W.S. Ayres, Gabriel Coll. (N.M.V.). 16 km W. of Lakes Entrance, Vic., 18 m (N.M.V.). Off Wilsons Promontory, Vic., Gabriel Coll. (N.M.V.). Off Cape Jaffa, S.A., 164 m, Verco Coll. (S.A.M.). Off Beachport, S.A., 365 m, Verco Coll. (S.A.M.). N.W. of Cape Borda, S.A., 113 m, Verco Coll. (S.A.M.). Coll. (S.A.M.).

FOSSIL RECORDS: Upper Pliocene: Cameron Inlet Formation, Hill's Dam at foot of Dutchman (E. side), Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.). Kalimnan: Jemmys Point Formation, 0-2 m, above beach in cliff, 50-100 m E. of Kalimna Jetty, lower shell bed (bed c), Vic. (N.M.V.). Mitchellian: Rose Hill Marl Member, Tambo River Formation, Moondara Farm, Mitton's (Old Rose Hill), about ½ way down hill near E. fence of paddock behind milking shed, Bairnsdale, Vic., coll. T. A. Darragh (N.M.V.).

DISTRIBUTION AND HABITAT: South Queensland to mid-South Australia, common on the continental shelf (see fig. 18).

REMARKS: The axial ribbing on the body whorl is generally much more frequently encountered in northern populations (i.e. central N.S.W. northwards) and is usually more pronounced than in southern populations.

This species is distinguished by its narrowly conical, shining, mostly smooth shell with the slightly contracted almost circular aperture.

Pisinna tumida tumida (T. Woods). Fig. 5f.

Diala tumida T. Woods, 1876b: 147; Tryon, 1887: 283; Tate & May, 1901: 391 (in part).

Estea tumida.—May, 1920: 60, pl. 15, fig. 9; May, 1921: 52; Gatliff & Gabriel, 1922: 147; May, 1923: pl. 24, fig. 9; Cotton, 1944: 292.

Pisinna tumida.—Macpherson & Gabriel, 1962. 92.

DIAGNOSIS: Shell—Small, solid, with heavy axial ribs and a nodular cord abapical to sutures.

Protoconch—Dome-shaped, of 1½-2 whorls. Wine-red in colour with typical sculpture.

Teleoconch—Conical, slightly convex spire; 3¾-4½ whorls, almost flat or slightly convex; sutures impressed. All whorls with strong axial ribs, rounded in section and slightly oblique, about 18 on body whorl, becoming sub-obsolete on last ¼ of body whorl, persisting on to base. A row of weak nodules abapical to sutures on last 2 whorls, strongest on body whorl. Base convex with weak spiral ridge on abapical part. Aperture subcircular, typical, inner lip slightly opisthocline. Varix weak, broad. Colour of spire reddish-orange to reddish-purple due to inner layer showing through. Body whorl and aperture yellowish-white or very pale yellowish-brown with 3 pale brown bands, one on abapical half of sutural row of nodules, other 2 on base, uppermost just abapical to periphery.

Dimensions:	length	diameter
Neotype	3.00 mm	1.34 mm

LOCATION OF TYPE: T.M. Neotype (7765/E424, C. 711), ex May Coll. Neotype here chosen (2 syntypes completely destroyed except for a few small, unidentifiable fragments (TM 7146/E15). No other type material known to exist).

TYPE LOCALITY: Frederick Henry Bay, S.E. Tasm. (original type locality Swansea, Tasm.).

ADDITIONAL MATERIAL EXAMINED: E. of Grassy, King Is., N.Tasm., ca. 58-77 m, 23 July 1962, H.M.A.S. "Gascoyne", stn G/68-70/62 (A.M.). W. of Kangaroo Is., Furneaux Group, N.E. Tasm., 49 m, 17 Jan. 1968, "Umitaka Maru", stn 68-35 N (T.M.). Bass Strait Islands, Tasm., exch. Petterd (A.M.). Off Waterhouse Point, N.E. Tasm., 36 m, 17 Jan. 1968, "Umitaka Maru", stn 68-31 N; 32 N (T.M.). Green Cape, Maria Is., Tasm., 5.5 m, on sublittoral algae, 26 Mar. 1970, coll. W. F. Ponder & D. C. Wolfe (A.M.). Pirates Bay, Eaglehawk Neck, S.E. Tasm., on intertidal rocks on coralline algae, 31 Mar. 1970, coll. W. F. Ponder (A.M.). Tasmania, pres. W. L. May (A.M.). Cowes, Vic., Robin Coll. (N.M.V.). Portsea, Vic., Gatliff Coll. (N.M.V.). Western Port, Vic., Gatliff Coll. (N.M.V.). Dredged off Rhyll, Vic., Gatliff Coll. (A.M.). MacDonnell Bay, S.A., Verco Coll. (S.A.M.). Port MacDonnell, S.A., Verco Coll. (S.A.M.). Off Middle Point, near Cape Northumberland, S.A., 13 m, on algae, 19 Mar. 1974, coll. S.A. Shepherd (A.M.). Off Beachport, S.A., 73 m, Verco Coll. (S.A.M.). Between Cape Jaffa and Kangaroo Is., S.A., 75-155 m, 24-26 July 1962, H.M.A.S. "Gascoyne", stn G2/71, 72, 76, 77/62 (A.M.). St. Francis Is., S.A., 27-36 m, Verco Coll., 2 lots (S.A.M.). 81 km S.W. of Cape Adieu, Gt. Aust. Bight, S.A., 32°42'S, 131°27'E, ca. 79 m, H.M.A.S. "Gascoyne", stn G2/90/62, 4 July 1962 (A.M.). Great Aust. Bight, S.A., 33°05'S, 128°40'E, 5 July 1962, H.M.A.S. "Gascoyne", stn G2/97/62 (A.M.).

FOSSIL RECORDS: Upper Pliocene: Cameron Inlet Formation, Hill's Dam at foot of Dutchman (E. side), Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.). Kalimnan: Grange Burn Formation, Forsythes Bank, S.E. side of Grange Burn, near Hamilton, Vic., in shell bed 2 m above creek, coll. T. A. Darragh (N.M.V.).

Both of these records are single specimens. They agree moderately well with Recent material except that their whorls are more convex. Both specimens are rather worn.

DISTRIBUTION AND HABITAT: Tasmania, Victoria W. of Wilsons Promontory to the eastern side of the Great Australian Bight (see fig. 16). Rarely found in the intertidal, living on sublittoral algae and dredged as dead shells on the continental shelf.

REMARKS: Differs from *P. olivacea olivacea* in having heavier axial ribs which are strong on all postnuclear whorls, and in possessing colour bands.

The 2 syntypes are destroyed to the extent that, in our opinion, they are completely unidentifiable. May (1920) figured a specimen, presumably from the lot from which the neotype has been selected, stating that he had carefully compared his specimens with the original type material.

Two subspecies are here recognised and described as new below. All three forms are separable from *P. olivacea olivacea*, to which they bear the closest resemblance, by their straighter, more widely separated axials and, in the case of *tumida tumida* which is over part of its range, sympatric with *olivacea olivacea*, by its larger shell which has colour bands.

Pisinna cf. tumida (T. Woods).

Two worn, damaged specimens similar to *tumida* from the Miocene of Victoria are too imperfect for accurate identification or description. They agree rather well with *tumida* except they are smaller than Recent specimens.

Dimensions:	length	diameter
	1.84 mm	0.84 mm
	1.84	0.88

LOCALITY: Miocene: Balcombian: "Clifton Bank", Muddy Creek, Vic. (=Muddy Creek Marl, lower beds), G. B. Pritchard Coll. (N.M.V., P. 33139).

Pisinna tumida simplicosta subsp. nov. Fig. 5h.

Rissoa olivacea.—Hedley, 1905: 42 (non Frauenfeld, 1867).

DIAGNOSIS: Shell—Small, solid, of pale colour, with strong, orthocline axial ribs.

Protoconch—Typical, of 1½ whorls, pink colour.

Teleoconch—Spire outline very slightly convex, whorls 3½-4, almost flat. Very strong, orthocline or very slightly prosocline ribs with about equal interspaces on all whorls, about 17 on penultimate whorl. A very weak cord causes indistinct nodulation of the axials immediately abapical to the sutures. Last 1/3 of body whorl (abaxial to varix) with weak, irregular riblets only. Aperture circular, outer lip slightly opisthocline in anterior portion. Varix broad, rather weak, about 1/3 whorl adaxial to aperture. Colour pale yellowish, spire pink, due to internal shell layer showing through the translucent shell.

Dimensions:	length	diameter
Holotype	2.00 mm	1.00 mm
Paratype	2.48	1.12

LOCATION OF TYPES: A.M. Holotype (C. 95041), 1 paratype (C. 95042) and 8 paratypes (C. 19885).

TYPE LOCALITIES: N.N.E. of Cape Moreton, S. Qld, 128-183 m, J. Voorwinde Coll. (C. 95041, C. 95042). E. of Cape Byron, N.S.W., 203 m, coll. G. H. Halligan (C. 19885).

ADDITIONAL MATERIAL EXAMINED: Noosa Heads, S. Qld, in beach drift, J. Voorwinde Coll. (A.M.) (5 worn specimens only tentatively identified as this species).

DISTRIBUTION AND HABITAT: South Queensland and northern N.S.W., in 128-203 m (see fig. 16). A related form, or the same subspecies, has been collected in beach drift at Noosa Heads, South Queensland.

REMARKS: This subspecies is extremely similar to *P. tumida wilsoni* nov. but differs from this and *P. tumida tumida* in having consistently more regularly orthocline axial ribs on the body whorl which tend to line up with the ribs on the previous whorls, a feature not often seen in *wilsoni*. The colour of the Queensland subspecies is pale yellowish and pink, this being in sharp contrast to the dark orange-brown West Australian subspecies. *P. tumida simplicosta* is readily distinguished from *P. olivacea olivacea* by its stronger, orthocline ribs, weaker row of gemmules, taller, less inflated spire and relatively smaller aperture.

Pisinna tumida wilsoni subsp. nov. Fig. 5g.

DIAGNOSIS: Differs from the typical form in being slightly smaller in size and of uniform deep red-brown colour, although faded specimens sometimes show a dark band on the abapical portion of the base; the axial ribs are often paler in colour, being more yellowish than the rest of the shell.

Dimensions:	length	diameter
Holotype	2.45 mm	1.20 mm

LOCATION OF TYPE: A.M. Holotype (C. 95037) and 14 paratypes (C. 95038). 2 paratypes in W.A.M.

TYPE LOCALITY: Off Dunsborough, S.W.A., 16 m, on algae on limestone and coral reef, coll. W. F. Ponder, B. R. Wilson & N. Coleman.

ADDITIONAL MATERIAL EXAMINED: 80 km S.W. of Cape Adieu, Great Aust. Bight, S.A., 32°42'S, 131°27'E, 79 m, 4 July 1962, H.M.A.S. "Gascoyne", stn G2/90/62 (A.M.). 129 km W. of Eucla, Great Aust. Bight, W.A., 148 m, Verco Coll. (S.A.M.). E. of Hood Point, W.A., 34°21'S, 121°16'E, 79 m, 9 July 1962, H.M.A.S. "Gascoyne", stn G2/109/62 (A.M.). West of Bold Is., W.A., 34°55'S, 119°00'E, 71 m, 7 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/150/62 (A.M.). S. of Wilson Point, W.A., 35°12'S, 117°00'E, 73-77 m, 8 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/160/62 (A.M.). W. of Bunbury, W.A., 33°03'S, 114°44'E, 156 m, 10 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/175/62 (A.M.).

DISTRIBUTION AND HABITAT: Western Great Australian Bight to S.W. Australia (see fig. 16). Deep sublittoral (16 metres) to 156 metres.

REMARKS: Two populations, here recognised as *tumida tumida* from the Great Australian Bight, are intermediate in size. Although all of the 28 specimens are faded to white, some show remnants of the three colour bands typical of *tumida tumida*.

This subspecies is named for Dr. B. R. Wilson who assisted greatly in the collection of samples of micro-Mollusca while one of us (W.F.P.) was in Western Australia.

Pisinna varicifera varicifera (T. Woods). Fig. 7c.

Rissoina varicifera T. Woods, 1877a: 101.

?Rissoa dubia Johnston, 1880: 33; Johnston, 1888: pl. 31, fig. 2, 2a; Pritchard, 1896: 116; May, 1919: 72 (non Defrance, 1827).

Estea varicifera.—May, 1919: 73, pl. 11, fig. 19.

Epigrus variciferus.—Chapman & Crespin, 1928: 113.

Zebinella varicifera.—Darragh, 1970: 205.

DIAGNOSIS: Shell—Small, solid, almost smooth, with deeply impressed, usually channelled sutures and tall spire.

Protoconch—Dome-shaped, of 1½-1¾ whorls.

Teleoconch—Spire outlines very slightly convex. 4½-5 lightly convex whorls which are usually sharply cut into the sutures. Sculpture very indistinct; close, very weak, axial riblets sometimes present on body whorl, otherwise smooth except for growth lines and occasional indistinct spiral scratches. Base convex. Aperture subcircular, inner and outer lips heavily thickened within. Outer lip opisthocline. Varix broad, moderately strong.

Dimensions:	length	diameter
Figured specimen	4.50 mm	1.75 mm

LOCATION OF TYPES: Lost? (Possibly unrecognised in the T.M.).

TYPE LOCALITY: Table Cape, Tasm. (Lower Miocene).

ADDITIONAL MATERIAL EXAMINED: Lower Miocene: Table Cape (=Fossil Bluff), N. Tasm., G. B. Pritchard Coll. (N.M.V.); coll. E. D. Atkinson (A.M.). Freestone Cove Sandstone (=lower bed), Table Cape, Tasm., Cudmore Coll. (N.M.V.). Fossil Bluff Sandstone (=upper bed), Table Cape, Tasm., Cudmore Coll. (N.M.V.). Bairnsdalian, Bullenmeri Clay, edge of Lake Bullenmeri, Jan. 1935, Parr Coll. (N.M.V.). Moondara Farm, Mitton's (=Old Rose Hill) about half way down hill near E. fence of paddock behind milking shed, Bairnsdale, Vic., coll. T. A. Darragh (N.M.V.). Upper Pliocene. Cameron Inlet Formation, Hill's Dam at foot of

Dutchman, on E. side, Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.). Cameron Inlet Formation; North Patriarch drain, 1 km E. of Link Road, a small side drain on S. side between first and second weirs E. of Link Road, near Monana, Flinders Is., coll. T. A. Darragh, Nov. 1964 (N.M.V.).

DISTRIBUTION: Lower Miocene to Upper Pliocene in N. Tasmania, Flinders Island and E. Victoria (see fig. 15).

REMARKS: *Rissoa dubia* Johnston is probably based on a juvenile shell of *varicifera*, as far as can be judged from the author's (1888) figure. Three specimens (ex Pritchard collection) in the National Museum of Victoria, which are presumably the basis of Pritchard's (1896) record and which bear the name *dubia*, are juvenile *varicifera*.

Many of the records listed by Chapman & Crespin (1928) refer to species other than *varicifera*, and some are not *Pisinna*.

The type has not been located in the Tasmanian Museum and may be lost.

This subspecies is ancestral to *P. varicifera relata* from which it differs in its more elongate shell, relatively smaller aperture and weaker sculpture.

Pisinna varicifera relata (Cotton). Figs 7d-g.

Rissoa tumida.—Tate and May, 1901: 391, 459, pl. 26, fig. 67 (not of T. Woods, 1876).

Scrobs bicolor.—Hedley, 1903: 355 (in part) (non Petterd, 1884).

Estea relata Cotton, 1944: 290, pl. 16, fig. 3.

Eusetia laterna Cotton, 1952: 51, pl. 3, fig. 11.

DIAGNOSIS: Shell—About medium size for genus, inflated, solid, grey to yellowish-brown with purple-red spire. Weak axial threads, especially on body whorl, and channelled sutures.

Protoconch—Dome-shaped, 1½-1¾ whorls. Purple-red; surface with close, spiral rows of minute pits.

Teleoconch—Spire slightly inflated, 3½-4½ whorls, moderately convex to almost flat; usually cut in sharply at sutures forming a narrow channel but this less pronounced in shells from western part of range. Sculpture of very fine, oblique (orthocline) irregular axial riblets on all whorls, which usually become more prominent and more oblique on body whorl; especially on shells from eastern part of range. Traces of subobsolete spiral sculpture can sometimes be seen. Sculpture is easily worn off. Base convex; aperture medium to moderately large, obliquely oval. Inner lip well separated from base, with fold developed behind lip in eastern shells; western shells with abapical portion of inner lip less raised and usually without a thickened fold behind. Outer lip extends beyond line of spire in eastern shells, not in western shells, edge slightly opisthocline. Varix broad, very weak to moderate. Colour yellowish-brown to greyish-white, a purple-red chitinous layer showing through on spire on fresh specimens. Dead shells uniform yellow, brown or white.

Dimensions:	length	diameter
Holotype	3.05 mm	1.62 mm
Paratype (large)	3.45	1.60
Paratype (small)	2.80	1.40
Holotype of *E. laterna*	3.40	1.70
Paratype of *E. laterna*	3.40	1.45
Figured specimen (N.S.W.)	4.58	1.92
Figured specimen (W.A.)	3.63	1.55

LOCATION OF TYPES: *Estea relata.* S.A.M. Holotype and 6 paratypes (D. 14186).

Of the 7 specimens in the type series, Cotton selected the most worn as the holotype.

E. laterna Cotton. S.A.M. Holotype (D. 14443) and 5 paratypes, one of which is an eatoniellid or rastodentid, another is *Pisinna* sp. and one an unidentifiable juvenile. The two remaining paratypes are *P. v. relata* one of which is broken.

TYPE LOCALITIES: *Estea relata.* 26 m, Gulf St. Vincent, S.A.

Eusetia laterna. 366 m. off Beachport, S.A., coll. J. C. Verco.

ADDITIONAL MATERIAL EXAMINED: Off Hallidays Point. N.S.W., 32°06'S, 152°54.2'E, 118 m, 5 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Soldiers Point, Port Stephens, N.S.W., 18 m, Voorwinde Coll. (A.M.). Off Cape Three Points, near Tuggerah Lakes, N.S.W., 75-91 m (A.M.). Off Broken Bay, N.S.W., 137 m. Voorwinde Coll. (A.M.). 35 km E. of Narrabeen, N.S.W., 146 m, pres. Haswell (A.M.). Off Sydney, N.S.W., 55-70 m, Voorwinde Coll. (A.M.). E. of Sydney, N.S.W., 150 m, H.M.A.S. "Gascoyne", stn G2/55-56/62, 18 July 1962, 2 lots (A.M.). 29 km E. of Malabar, Sydney, N.S.W., 192-203 m, 9 Aug. 1973, coll. Shelf Benthic Survey, stn 43 (A.M.). Off Botany Bay, N.S.W., 91-95 m (A.M.). Off Cronulla, N.S.W., 109 m, 2 Aug. 1964, H.M.A.S. "Gascoyne" (A.M.). Off Port Kembla, N.S.W., 115-137 m, "Thetis" stn 49 (A.M.). Crookhaven, N.S.W., 55 m, Voorwinde Coll., 2 lots (A.M.). Off Twofold Bay, N.S.W., 51 m, Voorwinde Coll. (A.M.). 24 km off Twofold Bay, N.S.W., approx. 37°26'S, 150°15'E, 75-154 m, H.M.A.S. "Gascoyne" stn G2/58-59/62, 19 June 1962 (A.M.). 32 km S.E. of Twofold Bay, N.S.W., 37°26'S, 150°15'E, 149 m, H.M.A.S. "Gascoyne", stn G2/59/62, 19 June 1962 (A.M.). E. off Grassy, King Is., Tasm., ca. 58-77 m, "Gascoyne", stn G2/68-70/62, 23 July 1962 (A.M.). Elephant Shoal Reef, S.E. of King Is., Bass Strait, on Telecommunication cable (N.M.V.). Off Waterhouse Point, N.E. Tasm., ca. 40 m, "Umitaka Maru" stns 68-30 N, 31 N, 32 N, 17 Jan. 1968, 3 lots (T.M.). Off Scamander, N.E. Tasm., 41°30'S, 148°17.5'E, 31 m, B.M.R. stn 2033, M.T. "Sprightly", 24 Mar. 1973, coll. P. H. Colman (A.M.). Off Piccaninny Point, N. of Bicheno, N.E. Tasm., 27 m, B.M.R. Stn. 2032, M.T. "Sprightly", 24 Mar. 1973, coll. P. H. Colman (A.M.). 4 km N.E. of Beaching Bay, Maria Is., E. Tasm., 42°27.5'S, 148°12'E, 82 m, F.R.V. "Penghana", 25 Mar. 1970, coll. W. F. Ponder (A.M.). Marion Bay, S. of Maria Is., E. Tasm., 42°50'S, 147°59.8'E, 58 m, B.M.R. stn 1993, M.T. "Sprightly", 13 Mar. 1973, coll. P. H. Colman (A.M.). 11 km E. of Cape Pillar, S.E. Tasm., 183 m, C. Hedley & W. L. May, 2 lots (A.M.). Derwent River, S. Tasm., W. L. May (A.M.). Derwent Estuary, Tasm. (A.M.). Killora Bay, Tinderbox, Derwent Estuary, S. Tasm., 14 m, Voorwinde Coll. (A.M.). D'Entrecasteaux Channel, S.E. Tasm., H.M.A.S. "Moresby", 24 Apr. 1965, Voorwinde Coll. (A.M.). D'Entrecasteaux Channel, S.E. Tasm., towards jetty, 43°05'36"S, 147°19'12"E, 7.5 m, 23 Mar. 1970, F.R.V. "Penghana", coll. W. F. Ponder (A.M.). 3 km S. of Tasman Head, S. Bruny Is., S.E. Tasm., 43°33'45"S, 147°19'21"E, 73 m, 24 Mar. 1970, F.R.V. "Penghana", coll. W. F. Ponder (A.M.). 58 km S. of Cape Conran, off Gippsland, Vic., 38°18'20"S, 148°38'40"E, 220-265 m, "Esso-Gipps", stn 10, May 1969, coll. C. Phipps (A.M.). 121 km S. of Cape Conran, off Gippsland, Vic., 148°31'50"E, 39°00'00"S, on continental slope, 183-146 m, shelly sand, "Esso-Gipps", stn 18, May 1969, coll. C. Phipps (A.M.). Off Rhyll, Western Port, Vic., dredged, 11-14 m, Gatliff Coll. (N.M.V.). Off Beachport, S.A., 365 m; 73 m, Verco Coll., 2 lots (S.A.M.). Off Cape Jaffa, S.A., 237 m, Verco Coll., 2 lots (S.A.M.). Between Cape Jaffa, S.A., and Kangaroo Is., S.A., 75-155 m, H.M.A.S., "Gascoyne", stns G2/71-72-76-77/62, 24-26 July 1962, 2 lots (A.M.). N.W. of Cape Borda, Kangaroo Is., S.A., 113 m, Verco Coll. (S.A.M.). 64 km S. of Cape Wiles, S.A., 183 m, F.R.V. "Endeavour" (A.M.). 51 km S.S.W. of St. Francis Is., S.A., 64 m (A.M.). Off St. Francis Is., S.A., 64 m, J. C. Verco (S.A.M.). 81 km S.W. of Cape Adieu, Great Australian Bight, S.A., 32°42'S, 131°27'E, ca. 79 m, H.M.A.S. "Gascoyne", stn G2/90/62, 4 July 1962 (A.M.). Great Australian Bight, S.A., 33°05'S, 128°40'E, 75 m, H.M.A.S. "Gascoyne", stn G2/97/62, 5 July 1962 (A.M.). 120 km E. of Rocky Point, Great Australian Bight, S.A., 33°43'S, 125°04'E, 77-80 m, H.M.A.S. "Gascoyne", stn G2/104/62, 7 July 1962 (A.M.). Between Eucla

and Esperance, W.A., 79-147 m, H.M.A.S. "Gascoyne", stns G2/96-97/62, 5 July 1962 (A.M.). E. of Cheyne Bay, W.A., 34°55'S, 119°00'E, 75 m, H.M.A.S. "Gascoyne", G3/150/62, 7 Aug. 1962 (A.M.). E. of Hood Point, S.W.A., 34°21'S, 120°16'E, 79 m, H.M.A.S. "Gascoyne", stn G2/109/62, 9 July 1962 (A.M.). E. of Hood Point, (N.E. of Albany), S.W.A., 150 m, H.M.A.S. "Gascoyne", stn G3/108/62, July 1962 (A.M.). W. of Bunbury, S.W.A., 33°03'S, 114°44'E. 156 m, H.M.A.S. "Gascoyne", stn G3/175/62, 10 Aug. 1962 (A.M.).

DISTRIBUTION AND HABITAT: Mid N.S.W. to E. Tasmania and S.W. Australia, on the continental shelf with a known depth range of about 13 to 365 m (see fig. 15).

REMARKS: The variation throughout the range of this subspecies is considerable. South eastern shelf specimens are readily distinguished from south western shelf specimens (c.f. figs 7e, 7f) but off the eastern coast of South Australia, populations are generally intermediate in form (figs 7d, 7g). A few South Australian specimens in the S.A.M. are like east coast shells and these grade into typical southern Australian specimens. The two species named by Cotton (*relata* and *laterna*) are both rather typical of the central southern shelf form. It thus appears that a cline exists from the south western form, which has a narrower shell, very weak axials (some almost smooth), a rather constricted aperture and weakly indented sutures, to a larger, distinctly axially sculptured shell with channelled sutures and a rather large aperture.

This species and *P. tasmanica* are the two common species on the south eastern shelf (including Tasmania). They are readily distinguished by the larger size of *varicifera relata* and the relatively finer axials (when *P. tasmanica* is axially sculptured the axials are rather few and coarse); and this together with the indented sutures of *varicifera relata*, allows separation to be readily achieved.

Pisinna vincula (Laseron). Figs 2h-i.

Scrobs vincula Laseron, 1950: 274, fig. 51.

Anabathron nothus Laseron, 1950: 275, fig. 58.

Obescrobs vincula.—Iredale & McMichael, 1962: 41.

Nannoscrobs nothus.—Iredale & McMichael, 1962: 42.

DIAGNOSIS: Shell—Minute, conico-pupoid, with weakly to strongly angled periphery and orange-red in colour.

Protoconch—Typical, and of 1½ whorls, wine-red in colour.

Teleoconch—Spire outlines weakly convex, 3-3¼ almost flat whorls with impressed sutures. Surface with growth lines only, sometimes these fairly conspicuous. A peripheral subangulation or angulation, sometimes a peripheral cord, and occasionally additional smooth cords abapical and adapical to sutures present. Base weakly convex. Aperture subcircular, inner lip thickened, separated from base in abapical portion, outer lip orthocline. Varix absent. Colour orange-red or red, base and aperture fading to yellowish, inner lip stained with orange-red over parietal area.

Dimensions:	length	diameter
Lectotype of *S. vincula*	1.54 mm	0.80 mm
Holotype of *A. nothus*	1.90	0.82

LOCATION OF TYPE: *Scrobs vincula*. A.M. Lectotype (C. 95043) and 1 paralectotype (C. 95044).

Anabathron nothus. A.M. Holotype (C. 95054).

TYPE LOCALITY: *Scrobs vincula*. Fairlight, North Harbour, Sydney, N.S.W., on algae in rock pools.

Anabathron nothus. Point Halliday, N.S.W., on algae.

Operculum—Typical.

Radula—Central teeth 2 + 1 + 2, outermost cusps very small and almost denticle-like, median cusp long, blunt with 2-3 denticles on cutting edge, about same width as bases of adjacent cusps. Lateral teeth 2+1+2-3, lateral cusps sharp, median cusp blunt. Inner marginal teeth with about 9 sharp cusps, outer marginal teeth finely dentate (general details and shape of cusps and teeth like those of *P. approxima* and *P. olivacea olivacea*).

ADDITIONAL MATERIAL EXAMINED: Off Flatrock, N. Stradbroke Is., S. Qld, 27-34 m, on algae, 2 Aug. 1971, coll. R. Ibara (A.M.). Off Crowdy Head, N.S.W., 32°38′9″S, 153°00′08″E, 91 m, 16 Dec. 1957, H.M.A.S. "Warrego" (A.M.). Forster, N.S.W., on green algae, open coast, lower littoral; on coralline algae, boulder beach, lower littoral, 4 Jan. 1969; coll. W. F. Ponder (A.M.). Fishermans Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Fingal Bay, Port Stephens, N.S.W., Voorwinde Coll. (A.M.). Pittwater, Broken Bay, N.S.W., dredged 1950-60, Voorwinde Coll. (A.M.). Narrabeen, Sydney, N.S.W., Voorwinde Coll. (A.M.). Long Reef, Collaroy, Sydney, N.S.W., 1950-60, Voorwinde Coll. (A.M.). North Harbour, Sydney, N.S.W., 18 m, Voorwinde Coll. (A.M.). Fairlight, Sydney, N.S.W., Voorwinde Coll. (A.M.). Middle Harbour, Sydney, N.S.W., C. Hedley, 2 lots (A.M.). Ny-ar-gine Point, Middle Harbour, Sydney, N.S.W., 19 Dec. 1968, coll. A.M. Party (A.M.). Chinamans Beach, Sydney, N.S.W., 3-7 m, Voorwinde Coll. (A.M.). E. of Sow & Pigs Reef, Sydney, N.S.W., near rocks, 1865, coll. J. Brazier (A.M.). Kurnell, Botany Bay, N.S.W., Voorwinde Coll. (A.M.). Gunnamatta Bay, Port Hacking, N.S.W., Voorwinde Coll. (A.M.). Honeymoon Beach, Jervis Bay, N.S.W., under stones, sand beach, lower littoral; red and brown algae, 18 Jan. 1969, coll. W. F. Ponder & N. Coleman (A.M.). Ulladulla, N.S.W., Voorwinde Coll. (A.M.). S. of Ulladulla, N.S.W., inside breakwater on sheltered reef, on small brown algae, 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Wimbie Beach, Batemans Bay, N.S.W., on exposed rocks, under stones, 6 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). Shelly Beach, Bermagui, N.S.W., Voorwinde Coll. (A.M.). Merimbula Jetty, exposed side, Merimbula, N.S.W., under stones, 7 Jan. 1970, coll. W. F. Ponder & P. H. Colman (A.M.). S.S.E. of Gabo Is., Vic., on red algae, 28 m, Feb. 1973, coll. P. Hutchings (A.M.).

DISTRIBUTION AND HABITAT: Restricted to N.S.W. and the south eastern corner of Victoria (see fig. 17), although it appears to be more abundant north of Sydney. Found alive at extreme low water on algae and beneath stones, as well as in the sublittoral, usually in open coastal situations.

REMARKS: The peripheral angulation is variable, occasionally barely noticeable and, rarely, the body whorl is strongly bi-keeled (as in the type of *nothus*). This species is very similar to *approxima* from which it differs in the peripheral angulation, consistent orange-red or red colour, flatter whorls, more conical shape and non-expanded aperture.

Pisinna voorwindei sp. nov. Fig. 7b.

DIAGNOSIS: Shell—Elongate, smooth, shining, with a small aperture.

Protoconch—Dome-shaped, of 1½ whorls, the tip broad and expanded, sculpture typical. Yellowish in colour (in type), fresher specimens reddish-pink.

Teleoconch—Narrow, elongate with about five rather flat, slightly stepped whorls. Smooth, shining, except for weak axial growth lines and close spiral scratches. Base convex; periphery evenly convex in adult, strongly angled in juveniles. Aperture small, slightly contracted. Inner lip spread over parietal region, not much separated from base

adapically; outer lip slightly opisthocline, varix absent. Colour white, the purplish-brown inner shell layer showing through on spire turning it to reddish-pink or red-brown to greyish on abapical 2/3 of whorls. Aperture with yellow lips, remainder white.

Dimensions:	length	diameter
Holotype	4.10 mm	1.42 mm

LOCATION OF TYPES: A.M. Holotype (C. 90351) and 6 paratypes (C. 95045).

TYPE LOCALITY: 120 km E. of Rocky Point, Great Australian Bight, S.A., 77-80 m, 33°43′S, 125°04′E, 7 July 1962, H.M.A.S. "Gascoyne", stn G2/104/62.

ADDITIONAL MATERIAL EXAMINED: "South Australia", Verco Coll. (S.A.M.). 80 km S.W. of Cape Adieu, Great Aust. Bight, S.A., 32°42′S, 131°27′E, 79 m, 4 July 1962, H.M.A.S. "Gascoyne", stn G2/90/62 (A.M.). Great Aust. Bight, S.A., 33°05′S, 128°40′E, 75 m, 5 July 1962, H.M.A.S. "Gascoyne", stn G2/97/62 (A.M.). Between Eucla and Esperance, W.A., 79-147 m, 5 July 1962, H.M.A.S. "Gascoyne", stn G2/96-97/62 (A.M.). E. of Hood Point, W.A., 34°21′S, 121°16′E, 79 m, 9 July 1962, H.M.A.S. "Gascoyne", stn G2/109/62 (A.M.). W. of Bald Is., W.A., 34°55′S, 119°00′E, 71 m, 7 Aug. 1962, H.M.A.S. "Gascoyne", stn G3/150/62 (A.M.).

DISTRIBUTION AND HABITAT: Great Australian Bight to at least as far W. as Bald Island in 75-147 m (see fig. 15).

REMARKS: The elongate, almost smooth shell of this species is very distinctive, differing from all of the other large species in its shape.

Cotton (1944) based his deep-water South Australian records of *Estea bicolor* on specimens of this species.

This species is named for Mr. J. Voorwinde of Sydney for his considerable contribution in providing much of the material on which this study has been based.

PART 2. TROPICAL AUSTRALIAN AND INDO-PACIFIC SPECIES.

Pisinna angulata sp. nov. Fig. 8b.

DIAGNOSIS: Shell—Small, elongate, with strong spiral ridges, abapical and adapical to suture, and weak, oblique axial ribs.

Protoconch—Dome-shaped, 1½ whorls.

Teleoconch—Spire outlines straight, sutures strongly stepped. 4 whorls, concave between abapical sutural ridge and adapical sutural cord. Adapical sutural cord increases in strength towards body whorl where it causes a distinct peripheral angulation. Oblique (prosocline), sharp, narrow, very numerous axial ribs cross surface, including spiral ridges and base, and occur on all whorls. Weak spiral scratches present. Base weakly convex. Aperture oval, outer lip almost orthocline, inner lip thickened, raised from parietal region and well separated from base. Varix weak. All specimens available have faded to white.

Dimensions:	length	diameter
Holotype	3.13 mm	1.13 mm
Paratypes (C. 95021)	2.80	1.10
(C. 95022)	4.00	1.40
	4.16	1.40

LOCATION OF TYPES: A.M. Holotype (C. 95020), and 9 paratypes (C. 95021, C. 95022, C. 95641); 2 paratypes in W.A.M.

TYPE LOCALITIES: ca. 216 km N.W. of Roebuck Bay, W.A., 17°34'S, 120°22'E, 188 m, 30 Nov. 1967, B.M.R., M.V. "Kos 2", stn K67-252 (2 specimens) (C. 95020, C. 95021). ca. 224 km N. of Cape Leveque, W.A., 14°29'S, 123°03'E, 124 m, 12 Nov. 1967, B.M.R., M.V. "Kos 2", stn K67-181 (1 specimen) (C. 95022). ca. 336 km N. of Broome, W.A., 14°50'S, 121°49'E, 230 m, 18 Nov. 1967, B.M.R., M.V. "Kos 2", stn K67-205 (9 specimens) (C. 95641).

DISTRIBUTION: Continental shelf of N.W. Australia in 100-200 m (see fig. 20).

REMARKS: A very distinct species which cannot be confused with any other species of *Pisinna*. The combination of a strongly angled body whorl with axial ribbing is not found in any other species of *Pisinna* and consequently the relationships of *P. angulata* are not clear.

Pisinna bikiniensis (Ladd). Fig. 8a.

Amphithalamus (Pisinna) bikiniensis Ladd, 1966: 62, pl. 12, fig. 1.

DIAGNOSIS: Shell—Minute, pupoid, polished, smooth except some have a few weak axial folds on body whorl.

Protoconch—Typical, of 1½ whorls. Teleoconch of 4 very weakly convex whorls; sutures moderately impressed. Aperture oval, slightly constricted, thickened within.

Dimensions:	length	diameter
Holotype	1.70 mm	0.70 mm
Figured paratype	1.78	0.80

LOCATION OF TYPES: U.S. National Museum, No. 648354 (holotype and paratypes). A.M. (1 paratype) (C. 77650).

TYPE LOCALITY: In drill hole 2B on Bikini Atoll, Marshall Group, Pacific, at 556-589 m (1839-1850 ft), early Miocene.

REMARKS: This species is the only fossil *Pisinna* known from the tropical Pacific. It is probably related to *P. chasteri* (Melvill & Standen) which, although sharing a tropical Pacific distribution, is well south of the Marshall Group. *P. chasteri* differs from *bikiniensis* mostly in being larger, and in having a more inflated spire.

Pisinna chasteri (Melvill & Standen). Figs 9c-e.

Barleeia chasteri Melvill & Standen, 1895: 120, pl. 3, fig. 22.

Estea ? chasteri.—Tomlin, 1936: 148.

DIAGNOSIS: Shell—Small, axially ribbed on last two whorls, usually whitish with a broad, brown band on the periphery and adapically to the sutures.

Protoconch—A rather pointed dome of 1½ convex whorls, red-brown in colour and with spiral rows of minute pits.

Teleoconch—Ovate-conical, spire weakly convex of 3½ very weakly convex whorls. Spire smooth except for axial growth lines, last 1½-2 whorls axially ribbed, the ribs rather weak, simple, slightly oblique (prosocline), usually obsolete on last ¼ of body whorl, about 23 on penultimate whorl in some specimens (usually obsolete over part of this whorl). Base weakly convex, with a weak bulge behind inner lip. Aperture subcircular, inner lip moderately thickened, not much separated from base in adapical portion. Outer lip orthoclinal, not protruding beyond line of spire. Varix weak or absent in most specimens, moderate to strong in some. Basic colour white, rarely uniform, usually with a broad brown band abapical to suture continued as a peripheral band on the body whorl, this sometimes

interrupted by white blotches. Sometimes spire is uniform brown and the peripheral band is often diffusely split into two bands (the adapical one narrow) by a row of closely spaced white spots. Axial ribs generally white on body whorl, except on basal part of colour band. Abapical part of base white; aperture white except for brown parietal wall.

Dimensions:	length	diameter
Holotype (fide Melvill & Standen)	1.75 mm	1.00 mm
Loyalty Is. (figured spec.)	2.20	1.00
Noumea, New Caledonia (figured spec.)	2.20	1.14
Noumea, New Caledonia (figured spec.)	1.80	0.94

LOCATION OF TYPES: Manchester Museum. Holotype and paratypes. Paratypes also in B.M.N.H.

TYPE LOCALITY: Lifu, Loyalty Islands.

ADDITIONAL MATERIAL EXAMINED: Lifu, Loyalty Is., near New Caledonia, ex T. Iredale Coll. (A.M.). Loyalty Is., Voorwinde Coll. (A.M.). W. side of Île Signal, off Noumea, New Caledonia, 25 Apr. 1972, on algae, 0-2 m, coll. P. H. Colman, 3 lots (A.M.). Ile St. Marie, Noumea, New Caledonia, S.W. point on high tide line, 2 May 1971, coll. P. H. Colman (A.M.).

DISTRIBUTION AND HABITAT: Loyalty Islands and New Caledonia (near Noumea). The only living material examined was from algae just below low tide in New Caledonia (see fig. 20).

REMARKS: The description is largely taken from the New Caledonian material because of its superior condition. Melvill and Standen state that the shell is "extremely smooth". The holotype and paratypes under low magnification superficially appear to be smooth but all have, in fact, worn axial ribs on the last whorl.

Pisinna colmani sp. nov. Fig. 9a.

DIAGNOSIS: Shell—Small, purple-brown with oblique, simple ribs on body whorl.

Protoconch—Typical, of 1½ whorls, wine red.

Teleoconch—Spire with lightly convex outline; 4 very slightly convex whorls. About 17-24 rounded, rather low prosocline axial ribs on body whorl, and ribs also on up to last 1/3 of penultimate whorl. Ribs with slightly narrower interspaces, becoming obsolete to subobsolete on base. Indistinct, irregular spiral striae present. Base convex. Aperture circular, heavily thickened within. Inner lip broad, thin: outer lip slightly opisthocline in abapical section. Varix low, broad. Colour of adapical spire purple-red, body whorl dull purple-brown with faint whitish blotches and a whitish band abapical to suture. Abapical base and outer lip yellowish-white.

Dimensions:	length	diameter
Holotype	2.73 mm	1.25 mm
Paratypes	2.42	1.22
	2.24	1.20
	2.80	1.28

LOCATION OF TYPES: A.M. Holotype (C. 95023) and 3 paratypes (C. 95024).

TYPE LOCALITY: 24 km S. of Double Island Point, near Maryborough, Qld, 26°09.5'S, 153°18.5'E, 56 m, 27 Oct. 1970, B.M.R. stn 1426, M.V. "San Pedro Sound" (A.M.).

DISTRIBUTION: Known only from the type locality (see fig. 20).

REMARKS: Differs from the northern New Zealand *P. hipkinsi* (Ponder) (fig. 9b), to which it is very similar, in having a more inflated body whorl, more nearly circular aperture and somewhat weaker axial ribs. The colour pattern is also different in the two species, *hipkinsi* having 2 brown bands on the body whorl and a paler body whorl and spire. In addition, a large brown colour spot behind the aperture in *hipkinsi* is absent in *colmani*. *P. colmani* is also similar to *P. kershawi* in having simple, oblique, axial ribs, but these do not extend on to the spire whorls as in *kershawi*; and the new species also differs in its darker colour, broader shell and glossy surface.

This species is named for Mr. P. H. Colman as a small mark of recognition for his considerable assistance in many ways during the course of this work.

Pisinna compressa (Laseron). Fig. 9h.

Scrobs compressa Laseron, 1956: 442, fig. 152.

DIAGNOSIS: Shell—Small, solid, smooth, shining, with relatively small aperture.

Protoconch—Dome-shaped, of 1½ whorls, with spiral rows of minute pits, dark wine-red in colour.

Teleoconch—Spire medium to rather tall, outline weakly convex; periphery sometimes subangled, strongly angled in juveniles; 3-3¼ very weakly convex whorls. Surface smooth except for weak axial growth lines, sometimes forming close, very weak ribs on body whorl, and faint spiral scratches. Base convex, usually with a weak ridge-like swelling abapically. Aperture almost circular, rather small, outer lip in line with spire; very slightly prosocline, orthocline or slightly opisthocline; inner lip not much raised from base in abapical section. Varix weak to moderate, rather broad. Colour dark orange-brown to yellowish-brown, spire usually darker than body whorl. Sometimes a broad, pale yellow, yellow-brown or white band abapical to sutures. Aperture white to brown, inner lip dark to pale brown.

Dimensions:	length	diameter
Holotype	1.60 mm	0.77 mm
Paratype	1.53	0.77

LOCATION OF TYPES: A.M. Holotype (C. 95025) and 7 paratypes (C. 95026) (1 a species of *Notoscrobs (Microfossa)*, and 1 *Pisinna tropica* (Laseron)).

TYPE LOCALITY: Michaelmas Cay, Qld, coll. T. Iredale.

ADDITIONAL MATERIAL EXAMINED: Murray Is., Torres Str., Qld, 9-14 m (A.M.). Michaelmas Cay, N. Qld, June 1926, "Great Barrier Exped." (A.M.). Great Barrier Reef, off Cairns, N. Qld, coll. Pitt, pres. McCulloch (A.M.). S.W. side of Euston Reef, off Cairns, N. Qld, 21 m, sandy bottom of steep coral wall, 30 Nov. 1972, coll. P. H. Colman (A.M.). Port Denison, Bowen, Qld, dredged, Voorwinde Coll. 2 lots (A.M.).

DISTRIBUTION AND HABITAT: North Queensland, from Murray Island to Bowen; shallow sublittoral to at least 20 m (see fig. 20).

REMARKS: This species differs from *perdigna* (Laseron) in its smaller size, thicker shell, shorter spire and different coloration. It is also similar to *tropica* (Laseron) from which it differs in its more solid shell, straighter spire outline, flatter whorls, non-expanded aperture and different coloration.

P. microthyra (Martens) from Mauritius is extremely similar to *P. compressa* but has a uniform colour, a narrower inner lip which is even less separated from the base abapically, and there is no basal ridge. The two species might well be shown to merge if more material becomes available from intermediate localities.

Pisinna eurychades (Watson). Fig. 8c.

Eulima eurychades Watson, 1883: 129 (err. *eurychada);* Watson, 1886: 522, pl. 37, fig. 7; Tryon, 1886: 278.

Estea eurychades.—Laseron, 1956: 441, fig. 149.

DIAGNOSIS: Shell—Elongate, smooth, whorls rather flat, aperture relatively small, contracted.

Protoconch—Broadly dome-shaped, of 1½ whorls; the first whorl large and evenly convex.

Teleoconch—Spire outlines nearly straight, base contracted. 4¾-5 whorls, flat, body whorl slightly convex. Surface smooth, glossy, with very fine growth lines and indistinct spiral striae. Base convex, retracted; aperture circular, not much thickened within; outer lip opisthocline in anterior section, its edge reflected outwards as a narrow, curved rim. Inner lip slightly separated from parietal region. Colour porcellaneous white, banded in the middle of each whorl with smokey-brown, the colour deepening at the apex (brown colour due to inner shell layer).

Dimensions:	length	diameter
Holotype (from dimensions given by Watson)	3.03 mm	1.27 mm
Figured syntype	3.24	1.22

LOCATION OF TYPES: B.M.N.H. 7 syntypes (reg. no. 87.2.9.1624-30); A.M. 3 syntypes (C. 35006).

Watson remarks that "40 or 50" specimens were located.

TYPE LOCALITY: Challenger stn 185 B, off Raine Island, Cape York, N. Australia, 11°38'15"S, 143°59'38"E, 284 m, in coral sand, 31 Aug. 1874.

DISTRIBUTION: Known only from the type locality (see fig. 20).

REMARKS: This species apparenthly has not been recollected since its original discovery. It is readily distinguishable, the elongate glossy shell and contracted, thin lipped aperture are features in which it resembles no other species.

Pisinna incipiens (Laseron). Figs 8e-f.

Scrobs incipiens Laseron, 1956: 443, fig. 153.

DIAGNOSIS: Shell—Small, pupiform, smooth, solid, with convex whorls and an inner rim in aperture. Colour pale yellow-brown with a broad brown band.

Protoconch—Dome-shaped, of 1½ whorls, yellowish, sculpture typical.

Teleoconch—Spire convex, of 2¾ convex whorls, sutures impressed. Sculpture of very indistinct axial threads and traces of spiral scratches over whole surface. Weak peripheral cord sometimes present. Aperture subcircular, inner lip rather thin, its edge straight across parietal region. A raised rim surrounds inner edge of aperture, well separated from edge of peristome. Outer lip orthoclinal to very slightly prosoclinal. Varix weak, base convex. Colour pale yellowish-brown to yellowish-white, with pale,orange-brown band on abapical ½ of spire whorls and middle of body whorl. Aperture yellowish-white, inner lip pale yellowish-brown.

Dimensions:	length	diameter
Holotype	1.55 mm	0.70 mm

LOCATION OF TYPES: A.M. Holotype (C. 95630) and 6 paratypes (C. 95631).

TYPE LOCALITY: Heron Island, Capricorn Group, Qld, under coral blocks, coll. J. Laseron.

ADDITIONAL MATERIAL EXAMINED: Heron Is., Qld, tide mark, J. Voorwinde Coll. (A.M.). Capricorn Group, Qld, J. Voorwinde Coll. (A.M.). Masthead Is., Qld, 31-37 m, pres. C. Hedley (A.M.).

DISTRIBUTION AND HABITAT: Capricorn Group, Queensland, lower littoral and shallow sublittoral (see fig. 20).

REMARKS: In the Capricorn Group this species is sympatric with, and very similar to, *P. tropica*. It differs in being slightly larger, with a more solid, more opaque shell which has a dull surface, not a shining one as in *tropica*. The very weak sculpture and the inner apertural rim are also features of *incipiens* which separate it from *tropica*.

The internal apertural rim is a unique feature of this species and provides a ready recognition point. It is possible that, on examination of the soft parts, a new genus-group name may be required. On shell characters however, apart from the apertural rim, this species is a typical *Pisinna*.

Pisinna kis (Winckworth). Fig. 8g.

Amphithalamus (Estea) kis Winckworth, 1931: 146.

DIAGNOSIS: Shell—Minute, solid, orange-brown, with narrow, oblique axial ribs on all whorls.

Protoconch—Dome-shaped, 1½ whorls, orange-brown in colour.

Teleoconch—Pupiform, spire convex, 2½-3¼ moderately convex whorls. Sculpture of oblique (prosocline), rather sharply rounded, narrow axial ribs on all whorls, interspaces 2-3 times wider than ribs, about 23-27 axials on body whorl, these continuing to outer lip, although slightly weaker on last part of body whorl. A very weak fold abapical to sutures present; ribs thickened slightly on fold. Base convex. Aperture rather large, oval, much thickened within, inner lip broad, almost straight across parietal region; edge of outer lip orthocline to very slightly opisthocline. Varix very weak, broad. Colour uniform orange-brown, fading to yellow-brown. When faded a narrow yellowish-white band present immediately abapical to sutural fold.

Dimensions:	length	diameter
Holotype (from original description)	1.3 mm	0.6 mm
Figured paratype	1.60	0.73

LOCATION OF TYPES: B.M.N.H. Holotype and 4 paratypes (No. 197440).

Additional paratypes National Museum of Wales (no number). Original Material consisted of 40 specimens.

TYPE LOCALITY: Trincomali, E. coast of Ceylon, 18 m (=Trincomalee, Sri Lanka).

DISTRIBUTION: Known only from the type locality.

REMARKS: This species is distinctive in its small size and in its narrow axial ribs which extend over all whorls. It is perhaps most similar to *P. oblata* which differs in its much finer, closer ribs which are predominent only on the last two whorls.

Winckworth states that the types are in his collection. The specimens in the National Museum of Wales include one marked type and 3 marked paratypes. There is also another series of several specimens with one separated and marked "figured specimen". The 5 specimens in the B.M.N.H. are also marked type and paratypes and the specimen here taken as the holotype is the one so marked in the B.M.N.H.

Pisinna microthyra (Martens). Fig. 8h.

Barleia? microthyra Martens, 1880: 285, pl. 20, fig. 18.

Rissoia (Amphithalamus) microthyra.—Tryon, 1887: 339, pl. 63, fig. 69.

DIAGNOSIS: Shell—Minute, smooth, simple, usually uniform orange-brown, sometimes with a white thread at suture. Protoconch typical.

Dimensions:	length	diameter
Type (from original description)	1.5 mm	0.6 mm
Figured specimen	1.60	0.76

LOCATION OF TYPES: Zoologischen Museum, Humboldt Univ., E. Berlin. Many syntypes. 3 syntypes in A.M. (C. 95800).

TYPE LOCALITY: Mauritius, Indian Ocean.

DISTRIBUTION: Only known from type locality.

REMARKS: The drawing is taken from a paratype in the A.M. This species differs from *P. tropica*, which it superficially resembles, in its more conical shape, in colour, and in the form of the aperture. *P. compressa* is very similar as noted in the remarks on that species.

Pisinna perdigna (Laseron). Fig. 9f.

Estea perdigna Laseron, 1956: 441, fig. 148.

DIAGNOSIS: Shell—Of medium size, solid, with rather tall, slightly convex spire, small aperture, smooth, shining surface and axial colour streaks.

Protoconch—Dome-shaped, of 1¾ whorls with spiral rows of minute pits; orange-brown to wine-red in colour.

Teleoconch—Rather elongate, spire outline slightly convex, sutures moderately distinct. Smooth except for very weak axial growth lines, and faint spiral scratches. Base evenly convex, aperture rather small, slightly retracted. Inner lip narrow, slightly raised from base in abapical portion; outer lip slightly prosocline; varix absent. Colour pale pinkish-white to purplish-brown with darker yellowish-brown or brown axial streaks extending from suture to suture and over base. A pale greyish band on adapical 1/3-1/2 of whorls visible in darker specimens. Aperture yellowish-white, inner lip orange-brown.

Dimensions:	length	diameter
Holotype	2.24 mm	1.00 mm
Topotype (small)	1.90	0.85
Topotype (large)	2.25	1.02

LOCATION OF TYPES: A.M. Holotype (C. 79575) and 6 paratypes (C. 79576). Also several topotypes (C. 19595).

TYPE LOCALITY: Masthead Island, Capricorn Group, Qld, 31-37 m, coll. C. Hedley.

ADDITIONAL MATERIAL EXAMINED: 3 km N.E. of W. side of Gillett Cay, Swains Reef, Southern Barrier Reef, Qld, 37-46 m; 64-73 m; 17-19 Oct. 1962, coll. A.M. party (A.M.). W. of North Keppel Is. Qld, 4 m, Voorwinde Coll. (A.M.). N.E. of Rockhampton, Qld, 22°50'S, 151°39'E, 64 m, B.M.R. str. 1261, M.V. "San Pedro Strait", 25 Sept. 1970 (A.M.).

DISTRIBUTION AND HABITAT: Southern Qld, from the Swains Reef to Masthead Island, in 4-73 m (see fig. 20).

REMARKS: *P. perdigna* is similar to *P. chasteri* in size but differs in its more elongate shape and in lacking axial ribs. This species is rather constant in shape and coloration.

Pisinna tropica (Laseron). Fig. 8d; 10e-f; 13e-f.

Scrobs tropica Laseron, 1956: 442, fig. 151.

DIAGNOSIS: Shell—Minute, pupiform, with protruding aperture and variable colour pattern.

Protoconch—Dome-shaped, of 1½ whorls, wine-red in colour and with spiral rows of minute pits.

Teleoconch—Spire convex, rather short, of 2¾ convex whorls. Surface smooth except for close, regular axial growth lines, usually very weak but in some specimens moderately prominent. Base convex with thickened rim behind abapical portion of inner lip. Aperture subcircular, edge of inner lip almost straight across parietal region, outer lip very slightly prosocline. Varix absent. Yellowish-brown, usually with spire darker orange-brown and irregular milk-white markings forming bands or rows of blotches adapical and abapical to sutures and, often a band on base. Sometimes uniform red-brown or orange-brown or almost uniform milky-white. Aperture pale yellowish-brown, inner lip darker brown.

Dimensions:	length	diameter
Holotype	1.26 mm	0.62 mm
Port Vila, New Hebrides	1.34	0.74

Operculum—Typical in all respects except for an elongated, low swelling a little in from middle of columellar edge (fig. 13e-f).

Radula—Central teeth 1 + 1 + 1, median cusp rectangular, up to 3 times length of lateral cusps, cutting edge almost flat, minutely serrate. A very minute denticle on outer side of each lateral cusp. Lateral teeth 2 + 1 + 2, innermost cusp very short (almost denticle-like), next large, pointed, median cusp a little longer, blunt, outer 2 cusps short, pointed. Inner and outer marginal teeth with about 7 small, sharp cusps (fig. 10e-f).

LOCATION OF TYPES: A.M. Holotype (C. 95053) and many paratypes (C. 95055).

TYPE LOCALITY: Heron Is., Capricorn Group, Qld, alive under coral blocks, coll. J. Laseron.

ADDITIONAL MATERIAL EXAMINED: Hood Lagoon, 112 km S.E. of Port Moresby, Papua (A.M.). E. side of Eagle Is., W. of Lizard Is., Qld, *Caulerpa* washings, 12 Dec. 1974, coll. P. H. Colman (A.M.). Green Is., off Cairns, N. Qld, on algae, 1969, coll. R. W. Ponder (A.M.). Michaelmas Cay, Qld, coll. T. Iredale (A.M.) (one of paratypes of *P. compressa* (Laseron)). Hook Reef, Proserpine, Qld, behind reef crest, 2 Oct. 1971, coll. I. Loch (A.M.). Hayman Is., Qld, Voorwinde Coll. (A.M.). Masthead Is., Capricorn Group, Qld, 31-37 m, pres. C. Hedley (A.M.). Heron Is., Capricorn Group, Qld, tide mark; 4 m on reef; Voorwinde Coll. 2 lots, (A.M.). S.E. of Heron Is., reef, Capricorn Group, Qld, 6 m, Voorwinde Coll. (A.M.). Capricorn Group, Qld, 11 m, Voorwinde Coll. (A.M.). S. outer face of One Tree Is.,

Capricorn Group, Qld, 1.5-4.5 m, 7 Dec. 1966, coll. F. H. Talbot (A.M.). Lagoon off Dawsons Point, Lord Howe Is., 25 m, 18 Feb. 1973, coll. J. Randall (A.M.). Lord Howe Is., outside reef, W. of Erscotts Passage, 18-24 m, steeply sloping bottom, Feb. 1973, coll. J. Randall (A.M.). Lord Howe Is., 3 lots, coll. R. Bell, pres. T. Iredale (A.M.). W. of Île Signal, off Noumea, New Caledonia, 0.2 m, on algae, on sandy and dead coral bottom, 25 Apr. 1972, 2 lots, coll. P. H. Colman (A.M.). Ile St. Marie, Noumea, New Caledonia, S.W. point on high tide line, 2 May 1971, coll. P. H. Colman (A.M.). Port Vila, Efate, New Hebrides, on algae, lower littoral, Jan. 1967, 3 lots, coll. W. F. Ponder (A.M.). Point Ardel, Port Vila, New Hebrides, under coral blocks and on algae, at low tide, Jan. 1967, coll. W. F. Ponder (A.M.). Vunda Point, S. of Lautoka, Viti Levu, Fiji, on short algae; on sheltered reef flat on algae under coral rubble, 15 Jan. 1967, coll. W. F. Ponder (A.M.). Suva, Fiji, pres. A. M. Hocart (A.M.).

DISTRIBUTION AND HABITAT: The Great Barrier Reef, Queensland, Lord Howe Island, New Caledonia, New Hebrides, Papua and Fiji. Living on algae and beneath coral blocks at low tide and in the shallow sublittoral (see fig. 20).

REMARKS: *P. tropica* can be readily distinguished by its small size, convex whorls, short bulbous spire and extended aperture. The only two similar tropical species are *P. incipiens* and *P. compressa*. The features distinguishing these species from *P. tropica* are discussed above.

The operculum of *P. tropica* bears a weak process not found in any other species of *Pisinna* yet examined. This species is also unusual in having such a wide distribution.

PART 3. TEMPERATE INDIAN OCEAN AND MEDITERRANEAN SPECIES

Pisinna cazini (Velain). Fig. 9j.

Rissoa cazini Velain, 1876: 285 (nomen nudum); Velain, 1877: 114, pl. 3, fig. 15.

Rissoia (Cingula) cazini.—Tryon, 1887: 344, pl. 71, fig. 84.

Estea cazini.—Dell, 1972: 35.

DIAGNOSIS: Shell—Smooth, bluish-white, with purplish apex. Whorls convex, aperture much thickened, inner lip rather narrow, outer lip opisthoclinal.

Dimensions:	length	diameter
From original description	2 mm	1 mm

LOCATION OF TYPES: Museum National D'Histoire Naturelle, Paris, 2 syntypes (no number).

TYPE LOCALITY: Island of St. Paul, Indian Ocean.

DISTRIBUTION: Type locality only.

REMARKS: The illustration is taken from a polaroid photograph of one of the syntypes.

Pisinna crawfordi (Smith). Fig. 9i.

Rissoia crawfordi Smith, 1901: 107, pl. 1, fig. 13.

Rissoa crawfordi.—Thiele, 1925: 77/43, pl. 5, fig. 44; Turton, 1932: 145; Barnard, 1963: 181.

DIAGNOSIS: Shell—Small, solid, elongate-pupoid, whorls moderately convex. Aperture subcircular, rather small, thickened within. Colour of spire reddish to purple, body whorl and aperture greyish.

Dimensions:	length	diameter
Holotype (from original description)	4.33 mm	1.50 mm

Operculum (from Barnard)—Oval, no internal process.

LOCATION OF TYPES: B.M.N.H. 3 syntypes (No 99.9.9.131-3).

TYPE LOCALITY: Algoa Bay, S. Africa, 36 m.

ADDITIONAL MATERIAL EXAMINED: "Valdiva" Expedition stns 95, 104 and 106 (stn 95, 34°51'S, 19°37.8'E, 80 m; stn 104, 35°16'S, 22°26.7'E, 155 m, off Cape Agulhas, S. Africa; stn 106, 35°26.8'S, 20°56.2'E (no depth given), Agulhas Bank, S. Africa (all in Zoologischen Museum, Humboldt Univ., E. Berlin).

ADDITIONAL RECORDS: Port Alfred (Turton); off Cove Rock (East London) in 40 m; Algoa Bay, 46 and 60 m; 34°5'S, 25°55'E, 123 m; 34°26'S, 25°42'E, 227 m; 34°27'S, 25°42'E, 468 m (all Barnard).

DISTRIBUTION: 36-468 m, southern coast of Africa.

REMARKS: The illustration is taken from a Polaroid photograph of one of the syntypes.

A species described by Turton (1932) is a possible additional species of *Pisinna*, but we have not had the opportunity of examining the unique type specimen. This is *Diala lara* (p. 137, pl. 30, fig. 986), from Port Alfred, S. Africa.

Pisinna punctulum (Philippi). Figs 9g; 10c-d; 12g; 13i.

Rissoa punctulum Philippi, 1836: 154, pl. 10, fig. 11.

Rissoa (Pisinna) punctulum.—Monterosato, 1878: 86.

Rissoa (Peringiella) glabrata.—Bucquoy, Dautzenberg and Dollfus, 1884: 312, pl. 37 (see also for additional references to *glabrata* auct. (in part) non *glabrata* v. Mühlfeldt).

Pisinna punctulum.—Monterosato, 1884: 26; Nordsieck, 1972: 165, pl. R4, fig. 31.

Amphithalamus (Pisinna) punctulum.—Nordsieck, 1968: 46, fig. 26.50.

DIAGNOSIS: Shell—Minute, pupoid, solid, smooth, reddish in colour.

Protoconch—Dark orange-red, dome-shaped, of 1½ whorls, sculpture of minute pits in spiral rows (fig. 12g).

Teleoconch—Spire lightly convex, whorls 21/3-23/4, moderately convex. Surface rather dull, smooth except for growth lines and exceedingly faint spiral scratches. Aperture subcircular, inner lip with edge convex, abapical portion well separated from base. Outer lip orthoclinal to slightly ophisthoclinal. Varix very weak. Colour orange-red to wine-red, aperture yellowish.

Dimensions:	length	diameter
Figured specimen	1.70 mm	0.80 mm

Operculum—Typical. Muscle insertion area occupying about half of surface. Columellar side with marginal area well defined (fig. 13i).

Radula—Central teeth rather large, typical in form, 1 + 1 + 1 with broad, blunt median cusp about twice width of lateral cusps. Lateral cusps sharp, narrow, about ½ length of median cusp. Denticles on either side in addition to cusps. Base of teeth with protruding

convex edge. Lateral teeth 2+1+2, median cusp broad, blunt, lateral cusps long, sharp. Inner marginal teeth with 8-10 small, sharp cusps, outer marginals with about 6 denticles (fig. 10c-d).

LOCATION OF TYPES: Not known.

TYPE LOCALITY: Sicily.

MATERIAL EXAMINED: Mediterranean Sea (A.M.). Mediterranean, ex Monterosato (A.M.). Island of Corsica (A.M.). Gulf of Marseilles, France (A.M.). Also several lots in various Museums in Europe, the B.M.N.H. and the U.S. National Museum (Nat. Hist.), all from the Mediterranean Sea.

DISTRIBUTION: Mediterranean Sea, living on coralline algae in the littoral zone.

REMARKS: In the most recent review of Mediterranean species of *Pisinna* Nordsieck (1972) has included 4 species in *Pisinna: — punctulum, sabulum* (Cantraine, 1842), *glabratum* (v. Mühlfeldt, 1824) (with a "form" *turritum* (Bucquoy, Dautzenberg and Dollfus, 1883)), and *seminulum* (Monterosato, 1877). We have not been able to examine any original material of *sabulum* (Cantraine) but it appears as though at least Nordsieck's interpretation of this species may fall within the variation of *punctulum*. He lists *punctum* Cantraine, 1842 as a synonym but "cotypes" of that species examined in the Naturhistorisches Museum, Vienna, are a *Peringiella* very similar to *nitida* Monterosato, 1878. *P. glabratum* seems best included in *Peringiella* on apertural features and *P. seminulum* probably belongs near *Barleeia*.

The fossil species *Cingula (Pisinna) pupa* (Doderlein) (as figured by Sacco, 1895: 33, pl. 1, fig. 91) from the Miocene of Italy is probably a *Pisinna* and may be ancestral to *punctulum*.

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Figure 2. a. *Pisinna castella* (Laseron), Off Crookhaven, N.S.W., holotype, A.M. (C. 94734). 1.88 mm × 0.90 mm. b. *P. megastoma* sp. nov., Pirates Bay, Eaglehawk Neck S.E. Tasmania, holotype, A.M. (C. 95031). 1.80 mm × 1.00 mm. c. *P. gradata* sp. nov., 360 km E. of Newcastle, N.S.W., 230-275 m, holotype, A.M. (C. 95027). 1.73 mm × 0.84 mm. d. *P. columnaria* (Hedley & May), Off Cape Pillar, S.E. Tasmania, 183 m, lectotype, A.M. (C. 29047). 2.65 mm × 1.00 mm. e. *P. approxima* (Petterd), Tamar Heads, Tasmania, lectotype, T.M. (7744/E403, TM10891). 1.65 mm × 0.75 mm. f. *P. approxima* (Petterd), (lectotype of *Estea gemma* Laseron), Crookhaven Heads, N.S.W., A.M. (C. 79211). 1.43 mm × 0.36 mm. g. *P. approxima* (Petterd), (syntype of *Estea cyclostoma var. rosea* T. Woods), Blackmans Bay, Tasmania, T.M. (7766/E425, TM5476). 1.46 mm × 0.65 mm. h. *P. vincula* (Laseron), (holotype of *Anabathron nothus* Laseron), Point Halliday, N.S.W., A.M. (C. 95054). 1.90 mm × 0.82 mm. i. *P. vincula* (Laseron), Fairlight, Sydney, N.S.W., lectotype, A.M. (C. 95043). 1.54 mm × 0.80 mm. j. *P. dubitabilis* (Tate), Tamar Heads, Tasmania, holotype, T.M. (7737/E396, TM10885). 2.10 mm × 1.05 mm. k & l. *P. laseroni* sp. nov., Off Lighthouse, Port Stephens, N.S.W., 71 m, holotype, A.M. (C. 95029). 2.50 mm × 1.22 mm, k. apertural view, l. side view.

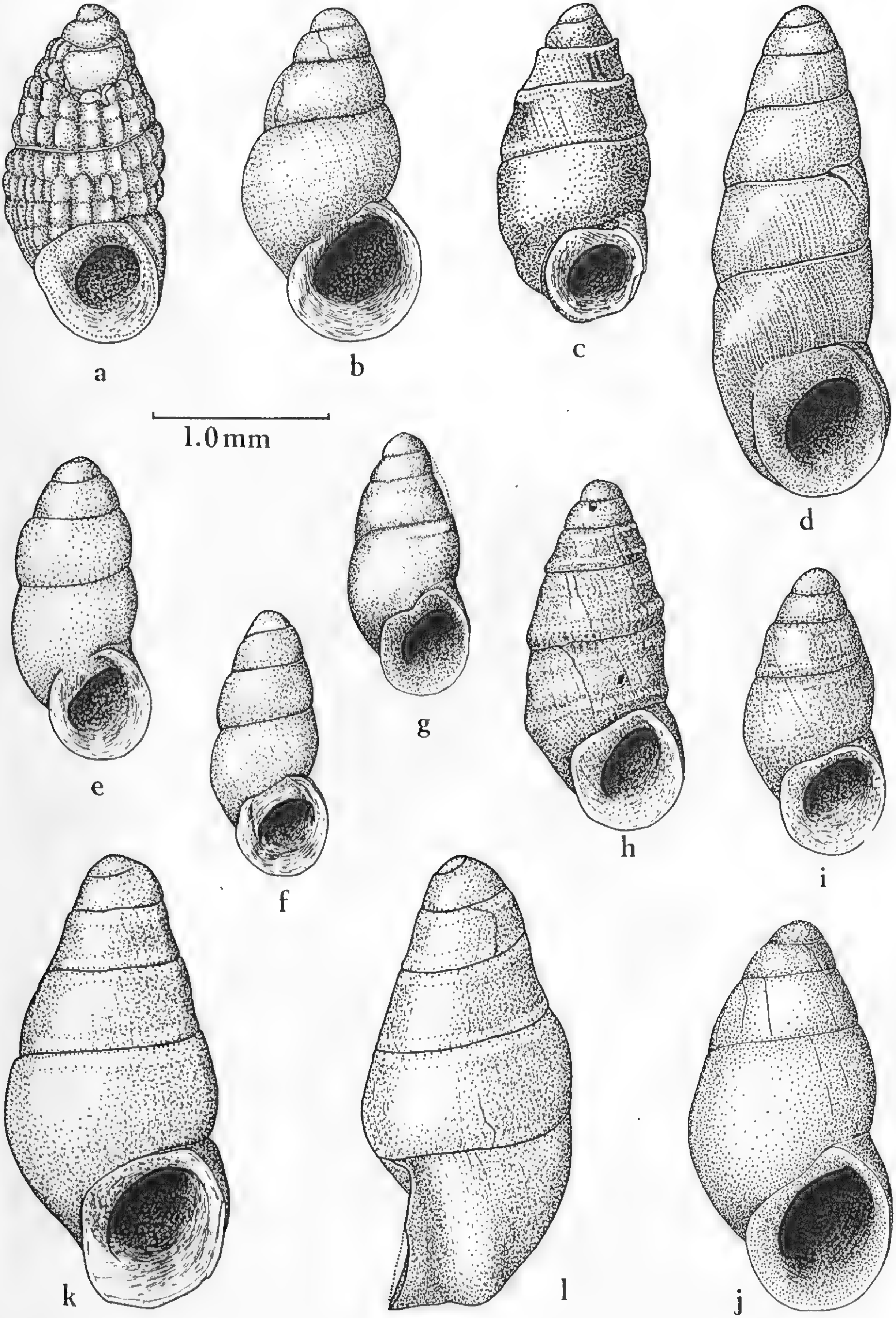

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Figure 3. a & b. *Pisinna circumlabra* sp. nov., Pirates Bay, Eaglehawk Neck, S. E. Tasmania, a. holotype, A.M. (C. 95783). 1.82 mm × 0.92 mm. b. paratype, A.M. (C. 95782). 1.62 mm × 0.87 mm. c. *P. albizona* (Laseron), North Harbour, Sydney, N.S.W., A.M. (C. 79210). 2.76 mm × 1.35 mm. d. *P. albizona* (Laseron), Point Halliday, N.S.W., lectotype, A.M. (C. 79208). 2.80 mm × 1.30 mm. e. *P. frenchiensis* (Gatliff & Gabriel), (paratype of *Dardanula difficilis* Gabriel), Elephant Shoal Reef, S.E. of King Is., Bass Strait, Tasmania, A.M. (C. 95048). 2.50 mm × 1.26 mm. f. *P. frenchiensis* (Gatliff & Gabriel), Portsea, Victoria, A.M. (C. 95047). 2.64 mm × 1.32 mm. g. *P. frenchiensis* (Gatliff & Gabriel), Long Bay, Tasmania, lectotype, T.M. (7143/E12, TM5475). 2.85 mm × 1.32 mm. h. *P. frenchiensis* (Gatliff & Gabriel), Lower Bed, Table Cape, Tasmania, Longfordian (Lower Miocene), N.M.V. (P. 33137). 2.30 mm × 1.17 mm. i-l *P. approxima* (Petterd), Pirates Bay, Eaglehawk Neck, S.E. Tasmania, A.M. (C. 95049). i. 1.52 mm × 0.70 mm; j. 1.56 mm × 0.74 mm; k. 1.58 mm × 0.72 mm; l. 1.76 mm × 0.72 mm.

Scale I — a, b, i, j, k, l.
Scale II — c, d, e, f, g, h.

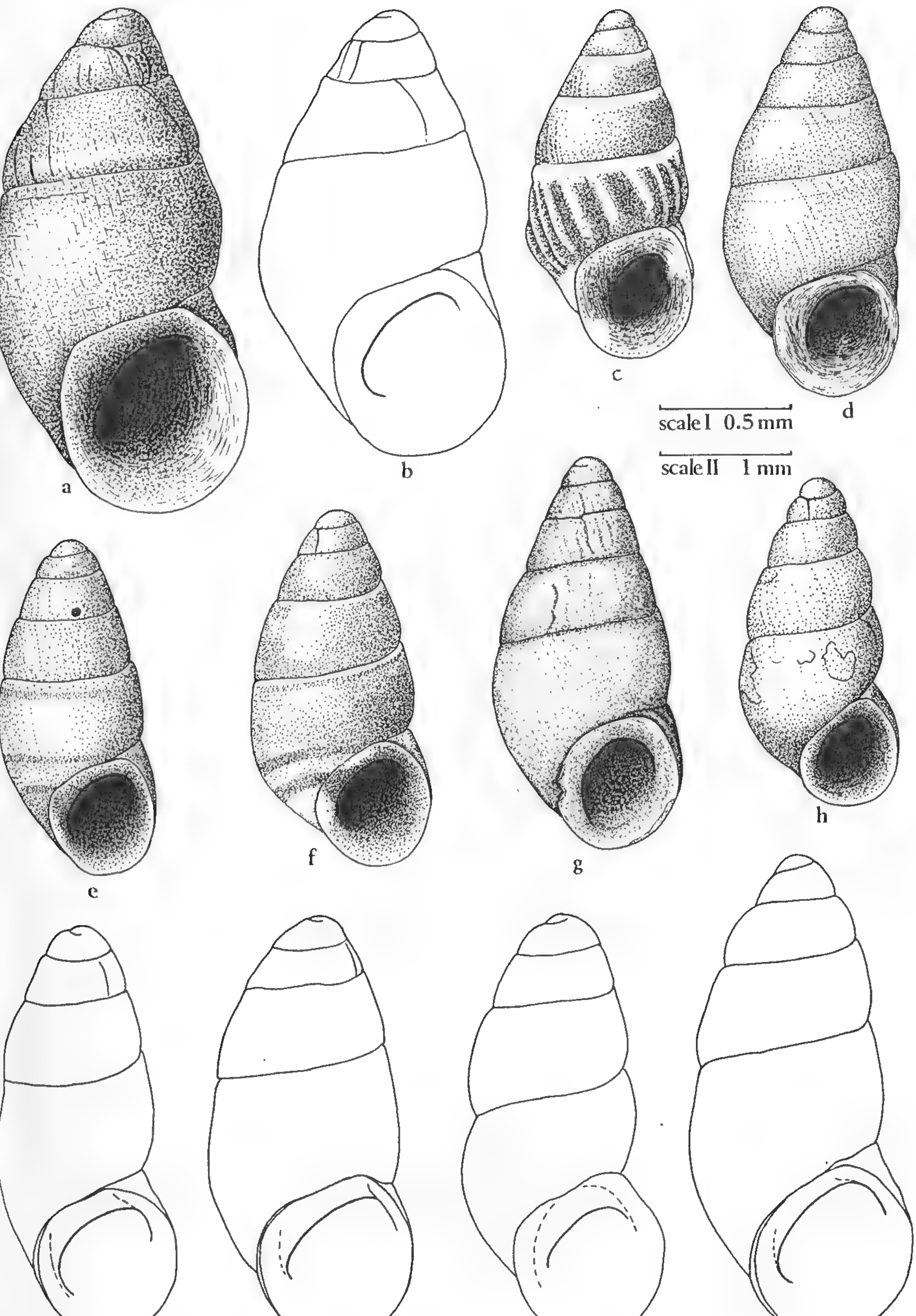

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Figure 4. a. *Pisinna costata* (Hedley), (paratype of *Estea hoggartae* Gabriel), S.E. of King Is., Bass Strait, Tasmania, N.M.V. (F. 16128). 3.15 mm × 1.45 mm. b. *P. costata* (Hedley), S. of Cape Wiles, S.A. 183 m, holotype A.M. (E. 4253). 3.10 mm × 1.40 mm. c. *P. kershawi* (T. Woods), (holotype of *Estea microcosta* May), E. of Cape Pillar, S.E. Tasmania, 183 m, T.M. (7753/E412, C. 1701). 2.70 mm × 1.17 mm. d. *P. kershawi* (T. Woods), Long Bay, Tasmania, lectotype, N.M.V. (F. 654). 2.58 mm × 1.24 mm. e. *P. frauenfeldi* (Frauenfeld), (lectotype of *Estea narrabeenensis* Laseron), Long Reef, Sydney, N.S.W., A.M. (C. 95571). 3.45 mm × 1.60 mm f. *P. frauenfeldi* (Frauenfeld), (lectotype of *Estea jervisensis* Laseron), Huskisson, Jervis Bay, N.S.W., A.M. (C. 95570). 3.70 mm × 1.82 mm.

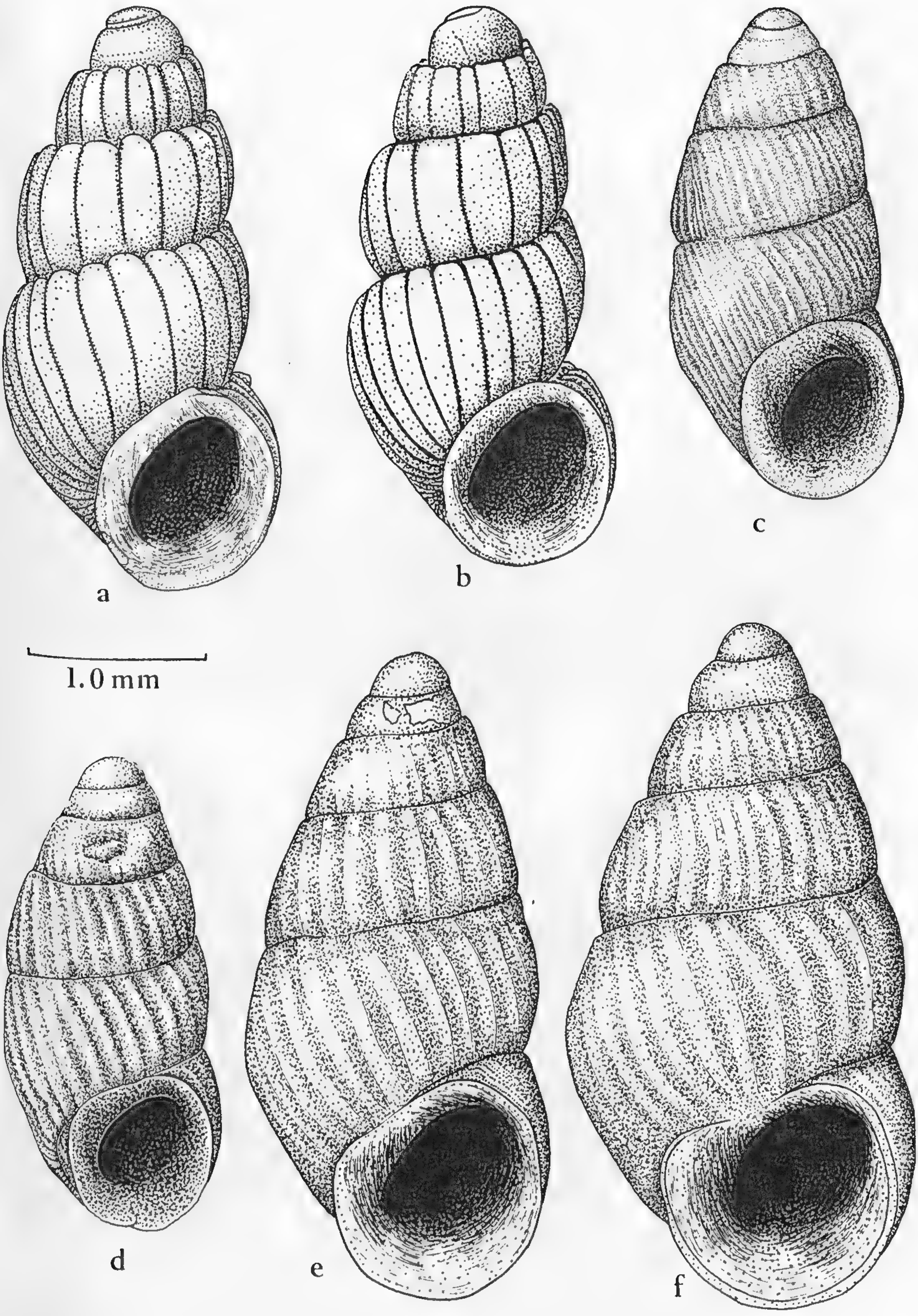
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Figure 5. a. *Pisinna flindersii* (T. Woods), N.W. Tasmania, syntype, T.M. (7747A/E406A, TM5486). 3.45 mm × 1.55 mm. b. *P. salebrosa* (Frauenfeld) S. side of Long Reef, Sydney, N.S.W., A.M. (C. 95050). 2.40 mm × 1.40 mm. c & d. *P. olivacea olivacea* (Frauenfeld), Fairlight, Sydney, N.S.W., A.M. (C. 90352). c. 2.15 mm × 1.15 mm; d. 1.72 mm × 0.93 mm. e. *P. olivacea olivacea* (Frauenfeld), (lectotype of *Rissoa diemenensis* Petterd), "Table Cape and Tamar Heads", Tasmania, T.M. (7145/E14, C. 268). 2.15 mm × 1.08 mm. f. *P. tumida tumida* (T. Woods), Frederick Henry Bay, S.E. Tasmania, neotype, T.M. (7765/E424, C.711). 3.00 mm × 1.34 mm. g. *P. tumida wilsoni* subsp. nov., Off Dunsborough, S.W.A., 16 m, holotype, A.M. (C. 95037). 2.45 mm × 1.20 mm. h. *P. tumida simplicosta* subsp. nov., Cape Moreton, Qld, 128–183 m, A.M. (C. 95041). 2.00 mm × 1.00 mm.

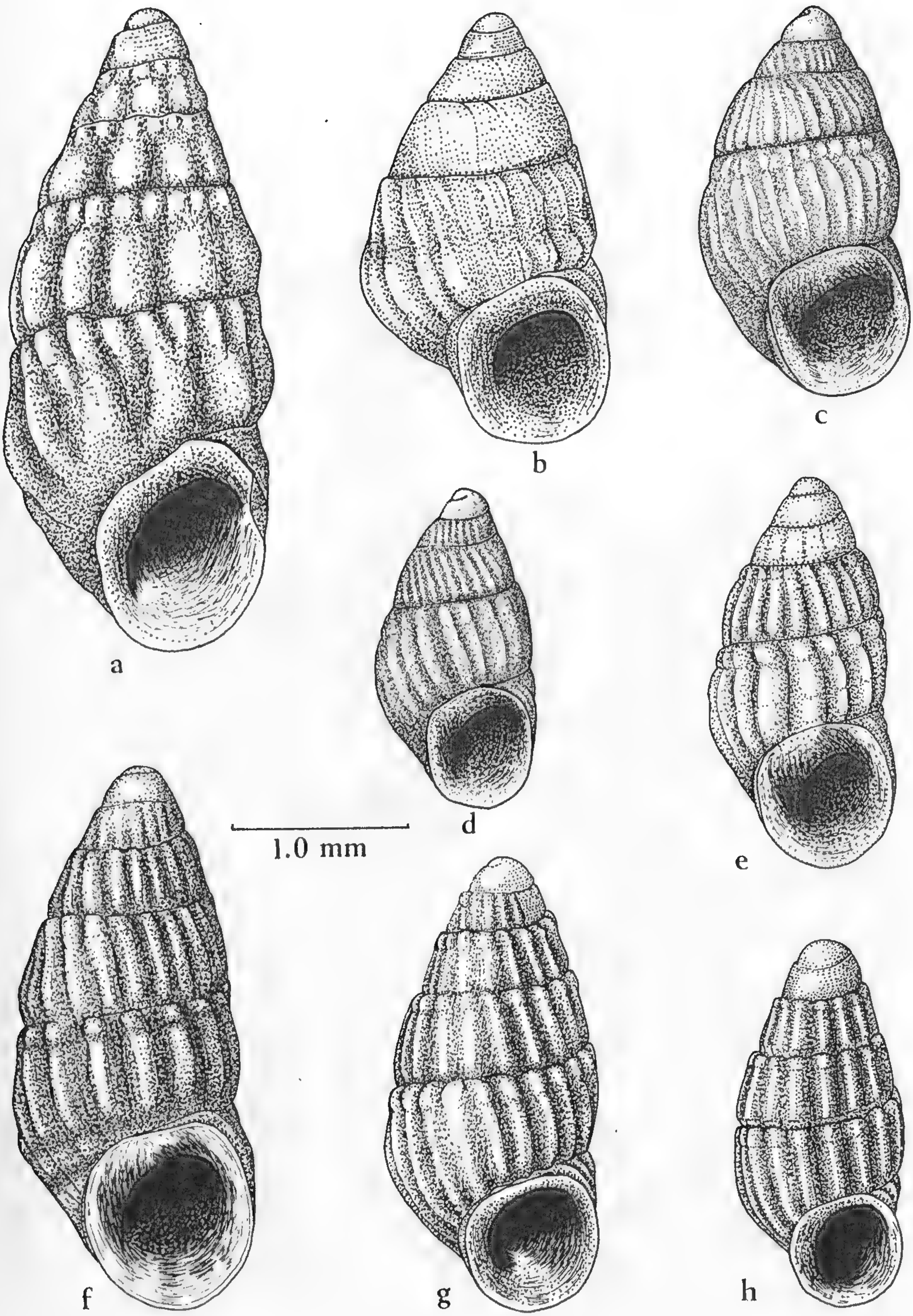
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Figure 6. a & b. *Pisinna oblata* (Laseron), Noosa Head, Qld, holotype, A.M. (C.79574). 1.46 mm × 0.67 mm. c. *P. oblata* (Laseron), Cronulla, N.S.W., A.M. (C. 95051). 2.30 mm × 1.00 mm. d & e. *P. tasmanica* (T. Woods), Off Crookhaven, N.S.W., 55-64 m, A.M. (C. 95046). d. 2.56 mm × 1.14 mm; e. 2.34 mm × 1.10 mm. f. *P. tasmanica* (T. Woods), Long Bay, Tasmania, holotype, T.M. (7762/E421, TM5428). 2.60 mm × 1.15 mm. g. *P. bicolor* (Petterd), South Tasmania, neotype. T.M. (7745/E404, TM5479). 3.96 mm × 1.80 mm. h & i. *P. nitida* sp. nov. Dredged between Sydney Heads, N.S.W., 27 m, i. holotype, A.M. (C. 95640). 5.20 mm × 2.08 mm; h. paratype, A.M. (C. 95052). 4.40 mm × 1.84 mm.

Scale I — a.
Scale II — others, except h.

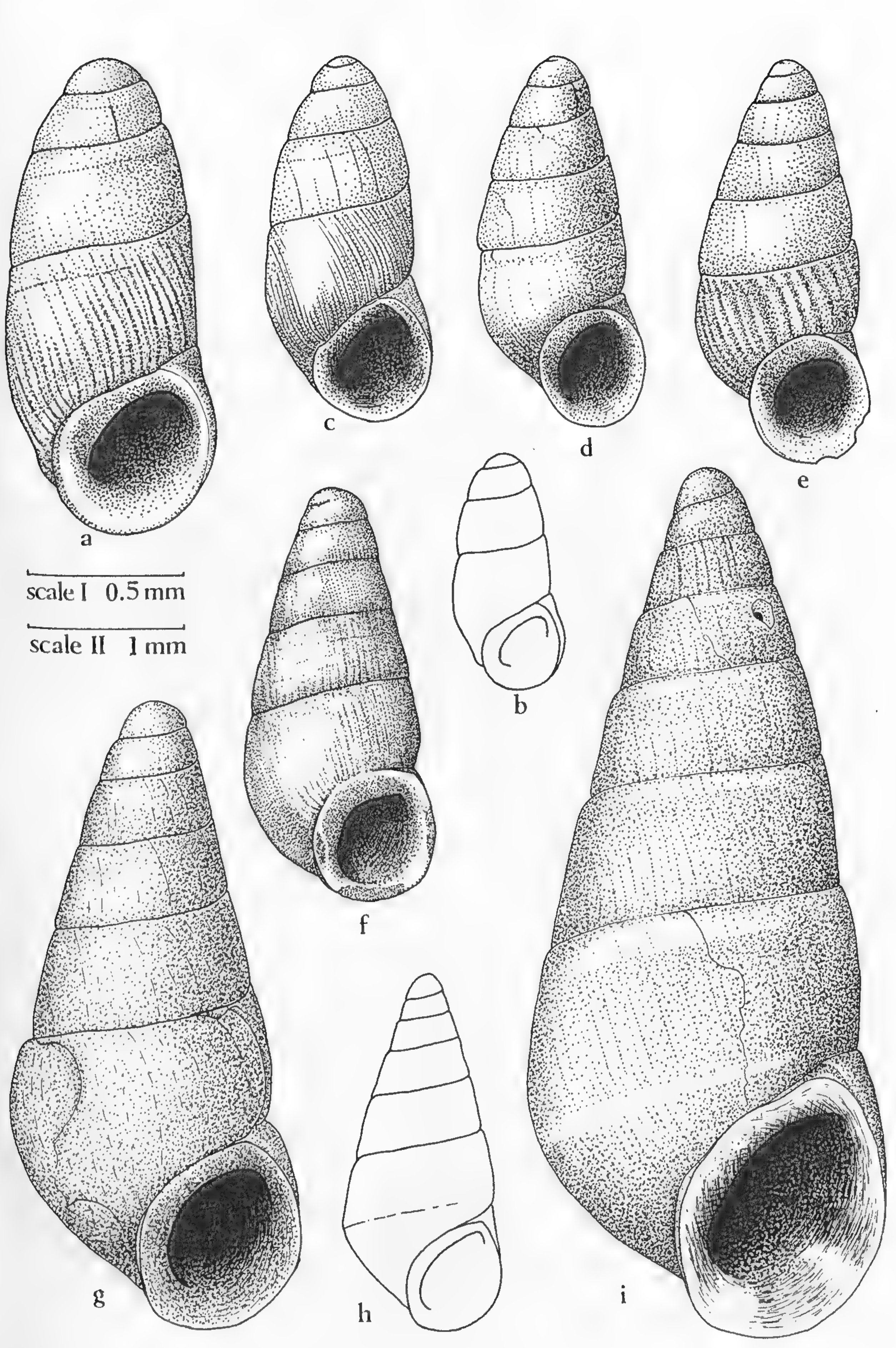
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Figure 7. a. *Pisinna moretonensis* sp. nov., N.E. of Cape Moreton Lighthouse, Qld, 115 m, holotype, A.M. (C. 95033). 5.40 mm × 2.42 mm. b. *P. voorwindei* sp. nov., E. of Rocky Point, Great Australian Bight, S.A., 77-80 m, holotype, A.M. (C. 90351). 4.10 mm × 1.42 mm. c. *P. varicifera varicifera* (T. Woods), Table Cape, Tasmania, N.M.V. (P. 33138). 4.50 mm × 1.75 mm. d. *P. varicifera relata* (Cotton), Gulf St. Vincent, S.A., holotype, S.A.M. (D. 14186). 3.05 mm × 1.62 mm. e. *P. varicifera relata* (Cotton), E. of Cheyne Bay, W.A., 75 m, A.M. (C. 95797). 3.63 mm × 1.55 mm. f. *P. varicifera relata* (Cotton), Off Port Kembla, N.S.W., 115-137 m, A.M. (C. 16313). 4.58 mm × 1.92 mm. g. *P. varicifera relata* (Cotton), (holotype of *Eusetia laterna* (Cotton), Off Beachport, S.A., S.A.M. (D. 14443). 3.40 mm × 1.70 mm. h. *P. paucirugosa* sp. nov., N.E. of Cape Moreton Lighthouse, Qld, 115 m, holotype, A.M. (C. 95035). 4.40 mm × 2.00 mm.

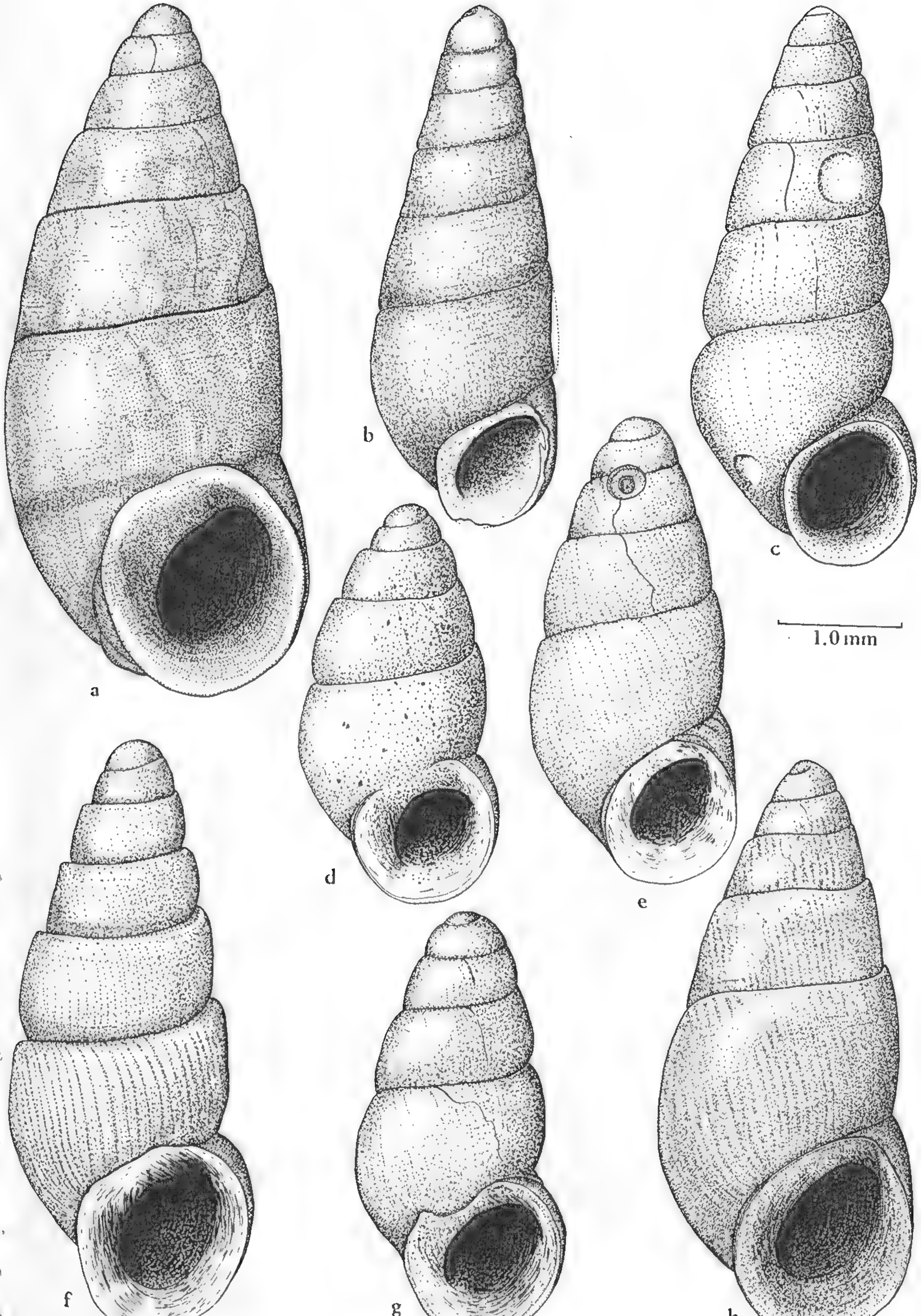
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Figure 8. a. *Pisinna bikiniensis* (Ladd), Bikini Atoll, Pacific, Early Miocene, paratype, A.M. (C. 77650). 1.78 mm × 0.80 mm. b. *P. angulata* sp. nov., N.W. of Roebuck Bay, N.W.A., 188 m, holotype, A.M. (C. 95020). 3.13 mm × 1.13 mm. c. *P. eurychades* (Watson), Off Raine Is., Cape York, N. Qld, 284 m, syntype, A.M. (C.35006). 3.24 mm × 1.22 mm. d. *P. tropica* (Laseron), Heron Is., Capricorn Group, Qld, holotype, A.M. (C. 95053). 1.26 mm × 0.62 mm. e & f. *P. incipiens* (Laseron), Heron Is., Capricorn Group, Qld, holotype, A.M. (C. 95630). 1.55 mm × 0.70 mm. f. enlarged aperture. g. *P. kis* (Winckworth), Trincomali, Ceylon, 18 m, paratype, B.M.N.H. (197440). 1.60 mm × 0.73 mm. h. *P. microthyra* (Martens), Mauritius, Indian Ocean, paratype, A.M. (C. 95800). 1.60 mm × 0.76 mm.

Scale I — a, f, g, h.
Scale II — b, c, d, e.

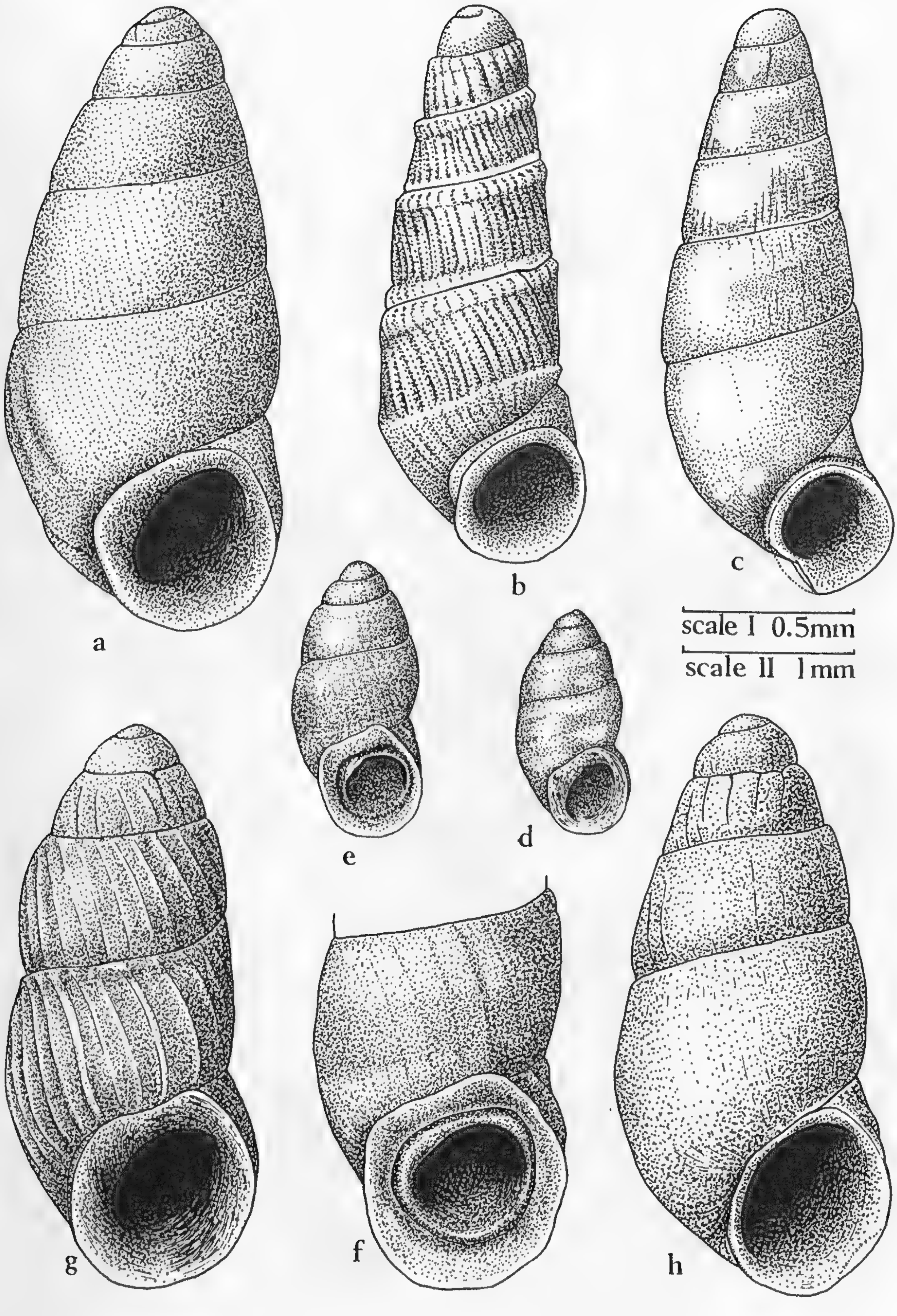
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Figure 9. a. *Pisinna colmani* sp. nov., Near Maryborough, Qld, 56 m, holotype, A.M. (C. 95023). 2.73 mm × 1.25 mm. b. *P. hipkinsi* (Ponder), Spirits Bay, New Zealand, holotype, Auckland Institute and Museum. 2.38 mm × 1.30 mm. c. *P. chasteri* (Melvill & Standen), Lifu, Loyalty Is., A.M. (C. 95799). 2.20 mm × 1.00 mm. d & e. *P. chasteri* (Melvill & Standen), Off Noumea, New Caledonia, 0.2 m, A.M. (C. 95798). d. 2.20 mm ×1.14 mm; e. 1.80 mm × 0.94 mm. f. *P. perdigna* (Laseron), Masthead Is., Capricorn Group, Qld, holotype, A.M. (C. 79575). 2.24 mm × 1.00 mm. g. *P. punctulum* (Philippi), Gulf of Marseilles, France, A.M. (C. 33023). 1.70 mm × 0.80 mm. h. *P. compressa* (Laseron), Michaelmas Cay, Qld, holotype, A.M. (C. 95025). 1.60 mm × 0.77 mm. i. *P. crawfordi* (Smith), Algoa Bay, S. Africa, 36 m, syntype, 4.33 mm × 1.5 mm (from original description). j. *P. cazini* (Velain), Isle St. Paul, Indian Ocean, syntype. 2 mm × 1 mm (from original description).

All same scale except i & j.

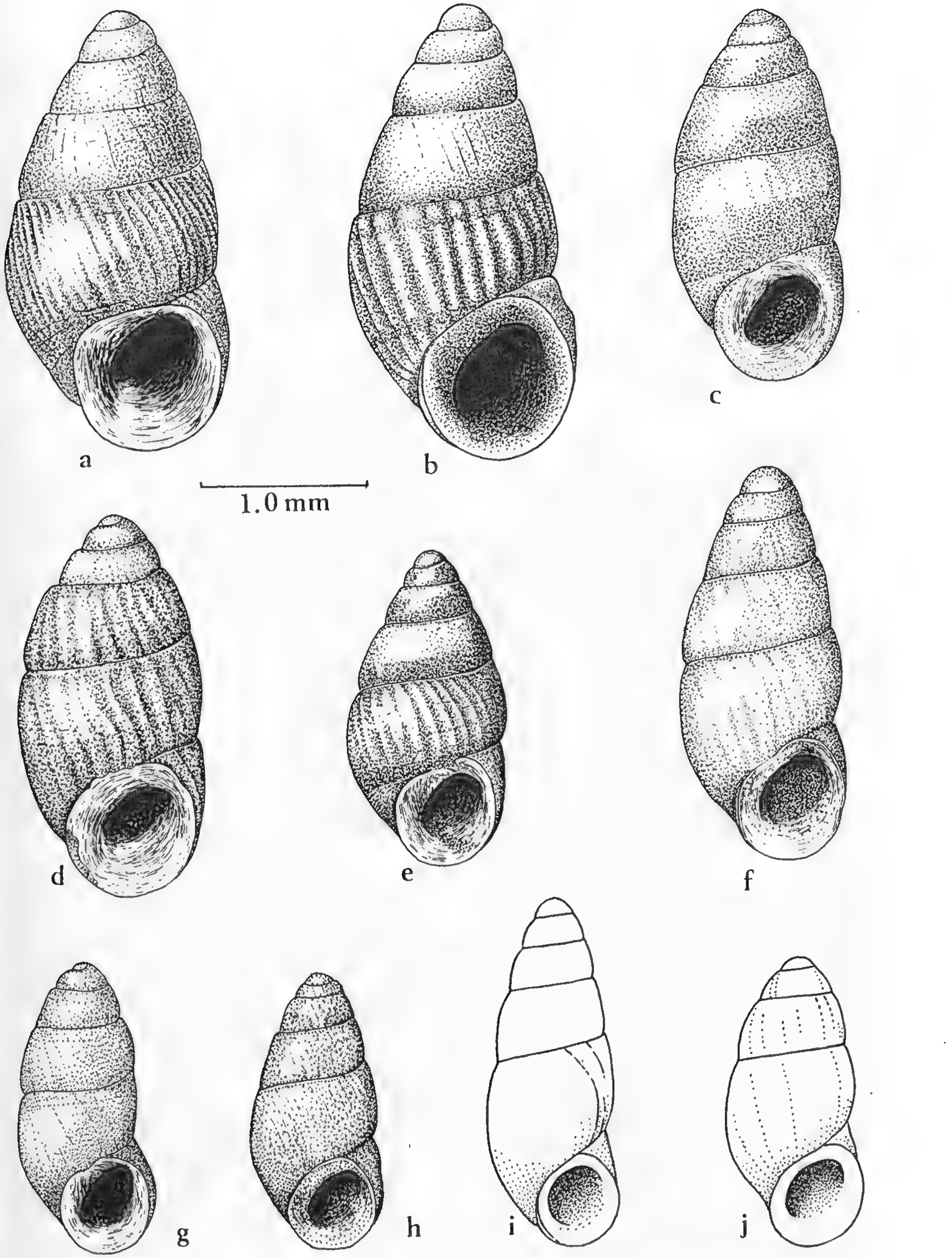
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Figure 10. RADULAE: a & b. *Pisinna albizona* (Laseron), Honeymoon Beach, Jervis Bay, N.S.W., in short turf-like red and brown algae, 18 Jan. 1969, coll. W. F. Ponder (S.E.M. Stub No. 37). a. × 1,700, b. × 1,700. c & d. *P. punctulum* (Philippi), Gulf of Marseilles, France (S.E.M. Stub No. 58). c. × 1,680, d. × 4,900. e & f. *P. tropica* (Laseron), S. outer face of One Tree Is., Capricorn Group, Qld, 1.5-4.5 m, 7 Dec. 1966, coll. F. H. Talbot (S.E.M. Stub No. 40). e. × 3,200. f. × 2,100.

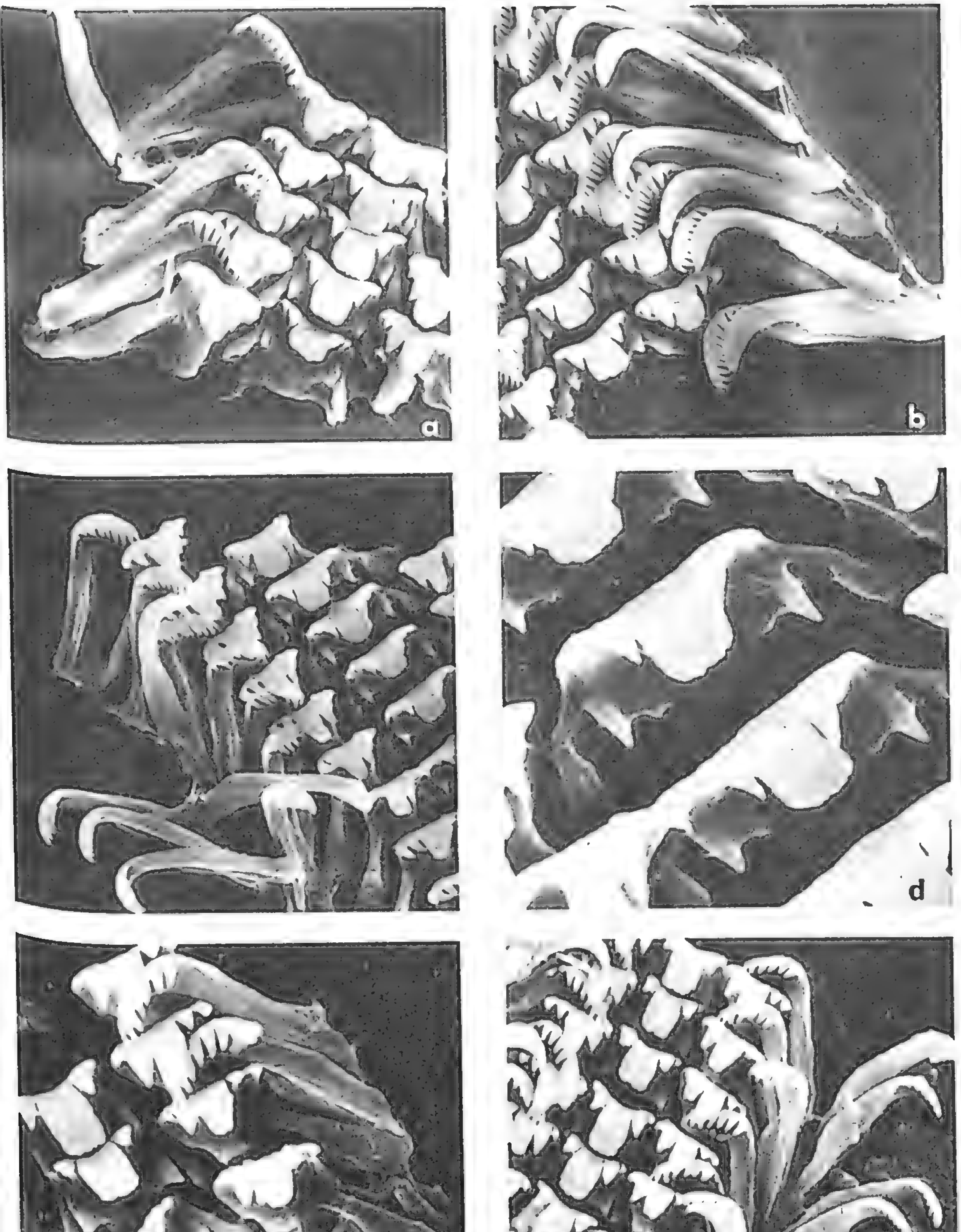
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Figure 11. RADULAE: a & b. *Pisinna approxima* (Petterd), Pirates Bay, Eaglehawk Neck, S.E. Tasm. under stones, low tide, 30 Mar. 1970, coll. W. F. Ponder (S.E.M. Stub No. 43). a. ×1,680, b. ×3,150. c. *P. megastoma* sp. nov., Pirates Bay, Eaglehawk Neck, S.E. Tasm., on coralline algae, 30 Mar. 1970, coll. W. F. Ponder (S.E.M. Stub No. 65). ×2,600. d. *P. circumlabra* sp. nov., Pirates Bay, Eaglehawk Neck, S.E. Tasm., in *Lessonia* holdfasts, 2 April 1970, coll. W. F. Ponder (S.E.M. Stub No. 63). ×2,700. e. *P. frenchiensis* (Gatliff & Gabriel), Pirates Bay, Eaglehawk Neck, S.E. Tasm., on brown algae, 31 Mar. 1970, coll. W. F. Ponder (S.E.M. Stub No. 66). ×2,100. f. *P. olivacea olivacea* (Frauenfeld), Balmoral, Sydney Harbour, N.S.W., on brown algae, 19 Jan. 1969, coll. W. F. Ponder & J. Voorwinde (S.E.M. Stub No. 38). ×1,600.

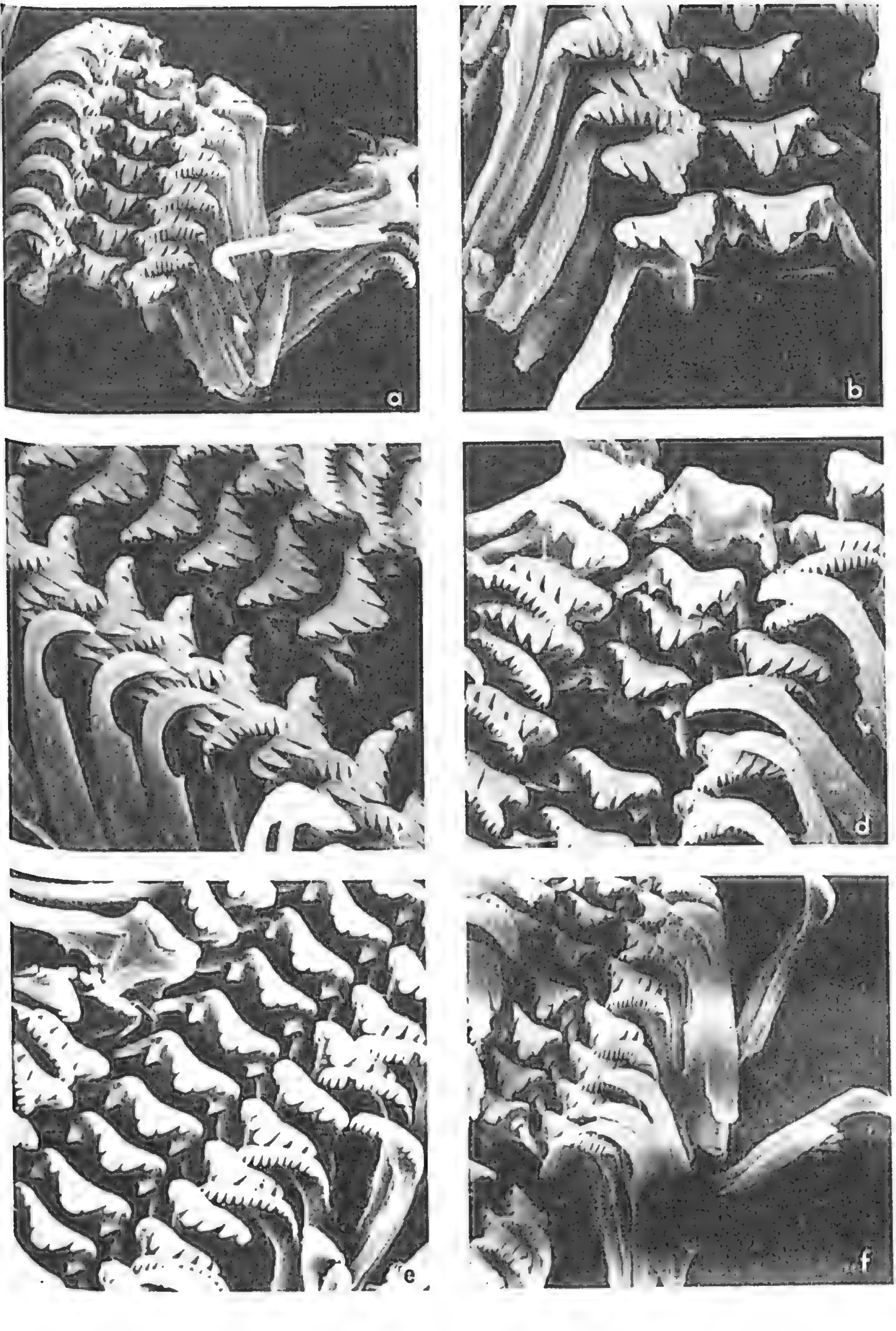
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Figure 12. a & b. *Pisinna costata* (Hedley), protoconch. 3.2 km S. of Tasman Head, S. Bruney Is., S.E. Tasm., 73 m (S.E.M. Stub No. 26). a. × 110, b. × 280. c & d. *P. olivacea olivacea* (Frauenfeld), fragment of shell showing inner chitinous shell layer. Ulladulla, N.S.W. (S.E.M. Stub No. 27). c. × 210, d. × 2,100. e & f. *P. olivacea olivacea* (Frauenfeld), protoconch. North Harbour, Sydney, N.S.W. (S.E.M. Stub No. 18). e. × 560, f. × 170. g. *P. punctulum* (Philippi), protoconch. Gulf of Marseilles, France (S.E.M. Stub No. 68). × 150.

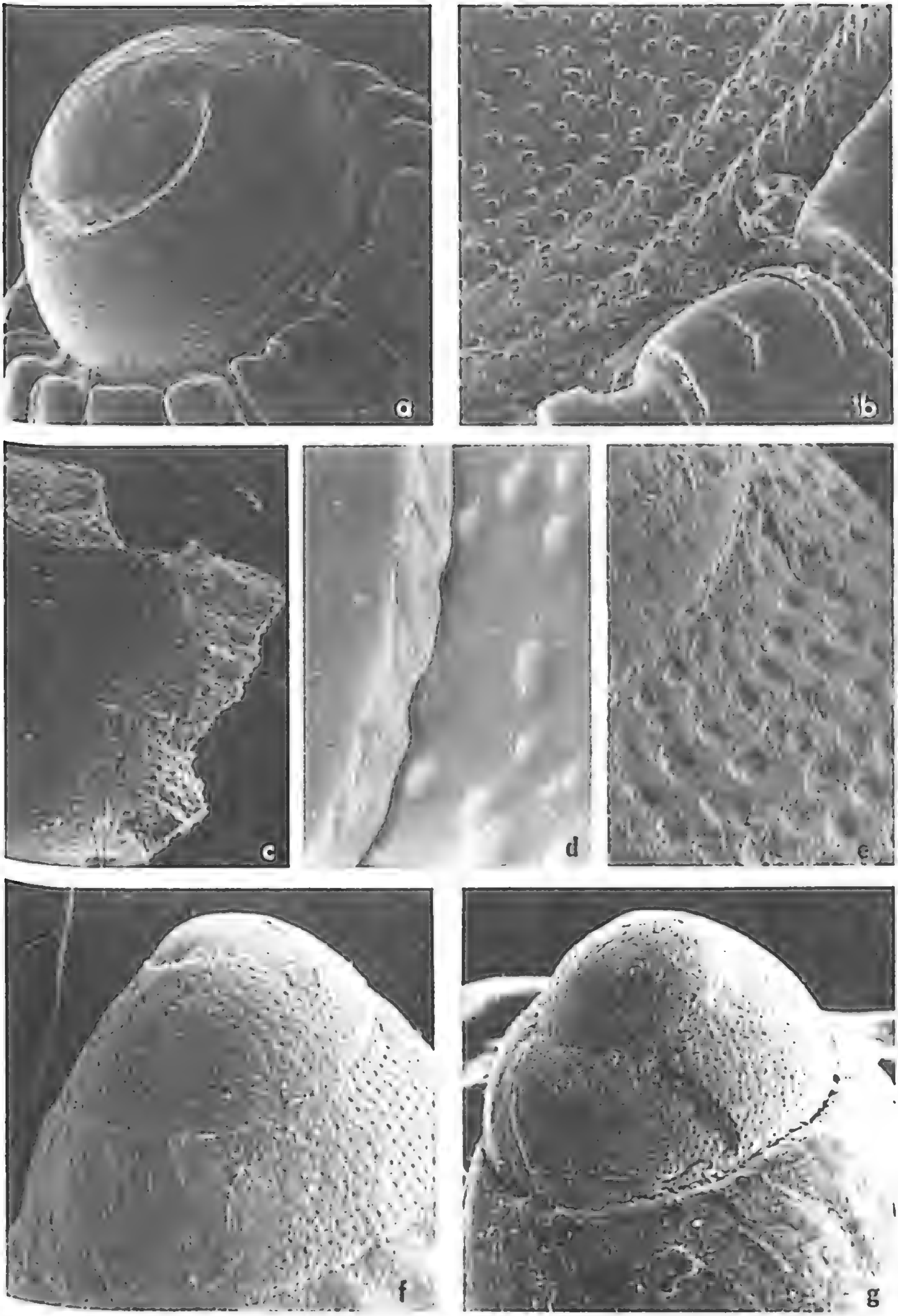
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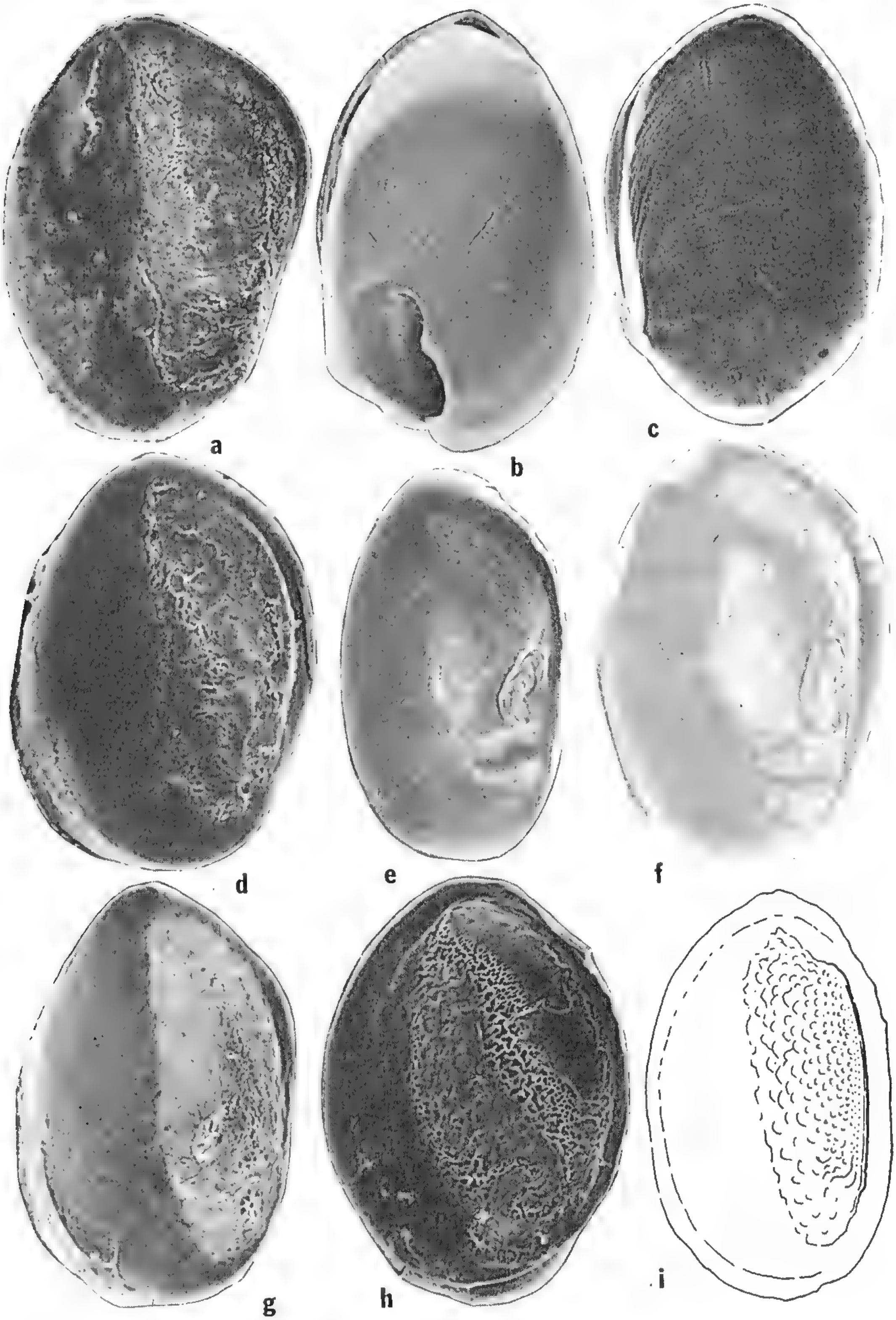
Figure 13. OPERCULA: a. *Pisinna albizona* (Laseron), Honeymoon Beach, Jervis Bay, N.S.W., short red and brown algae, 18 Jan. 1969, coll. W. F. Ponder (S.E.M. Stub No. 23). ×130. b. *P. megastoma* sp. nov., Pirates Bay, Eaglehawk Neck, S.E. Tasm., on coralline algae, 30 Mar. 1970, coll. W. F. Ponder (S.E.M. Stub No. 65). ×280. c & d. *P. olivacea olivacea* (Frauenfeld), N. end of Balmoral, Sydney Harbour, N.S.W., 1-2 m, 21 Jan. 1973, coll W. F. Ponder (S.E.M. Stub No. 22). c. ×140, d ×150. e & f. *P. tropica* (Laseron), S. outer face of One Tree Is., Capricorn Group, Qld, 1.5-4.5 m, 7 Dec. 1966, coll. F. H. Talbot (S.E.M. Stub No. 28). e. ×210, f. ×240. g. *P. frenchiensis* (Gatliff & Gabriel), Pirates Bay, Eaglehawk Neck, S.E. Tasm., on brown algae, 31 Mar. 1970, coll. W. F. Ponder (S.E.M. Stub No. 66). ×130. h. *P. frauenfeldi* (Frauenfeld), S. side of Ulladulla, N.S.W., 5 Jan. 1970, coll. W. F. Ponder & P. H. Colman (S.E.M. Stub No. 22). ×80. i. *P. punctulum* (Philippi), Gulf of Marseilles, France (S.E.M. Stub No. 25). ×150.

(figures b and c show the outer side of the operculum, the remainder show the inner side).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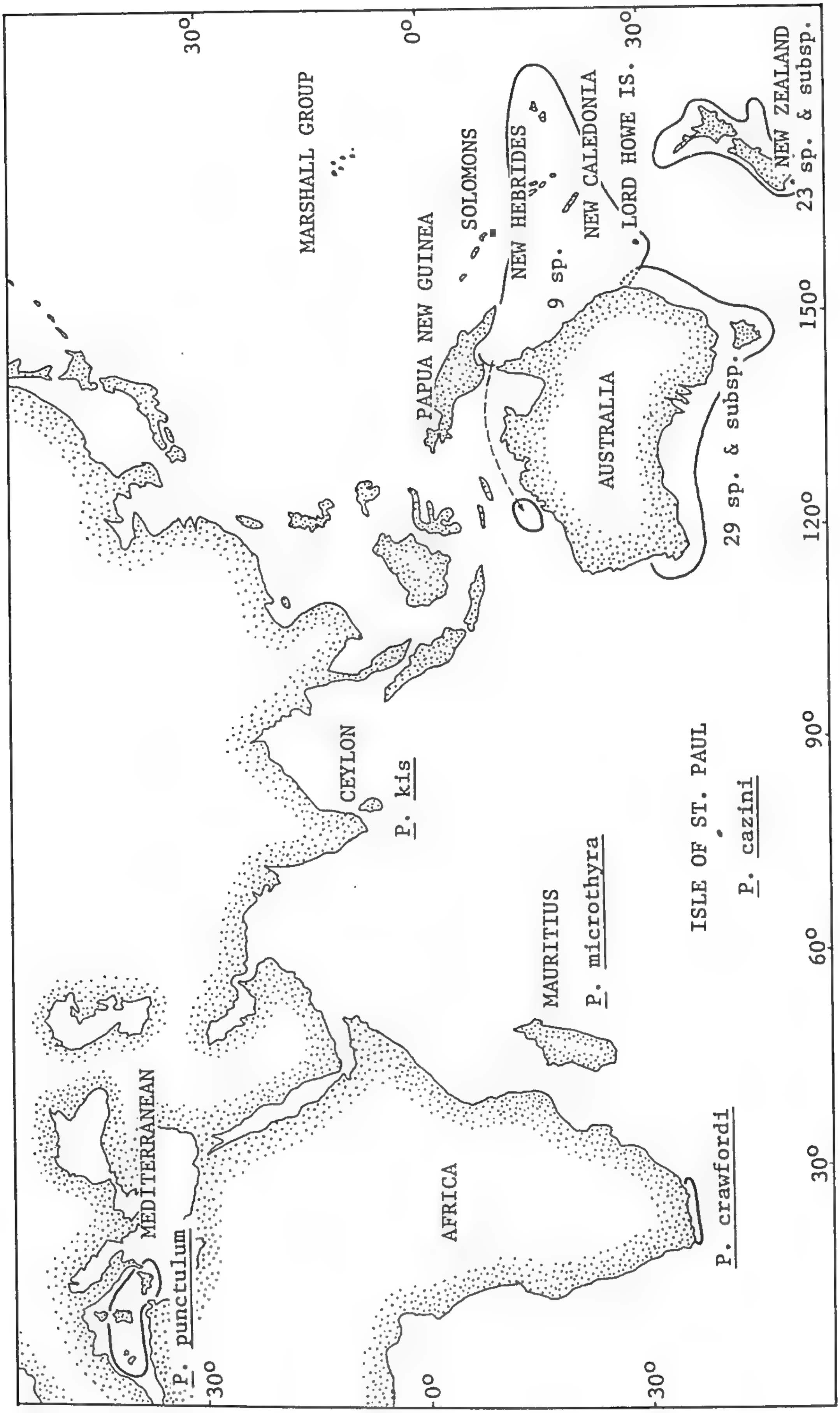

Figure 14. Distribution of the Recent species of *Pisinna*.

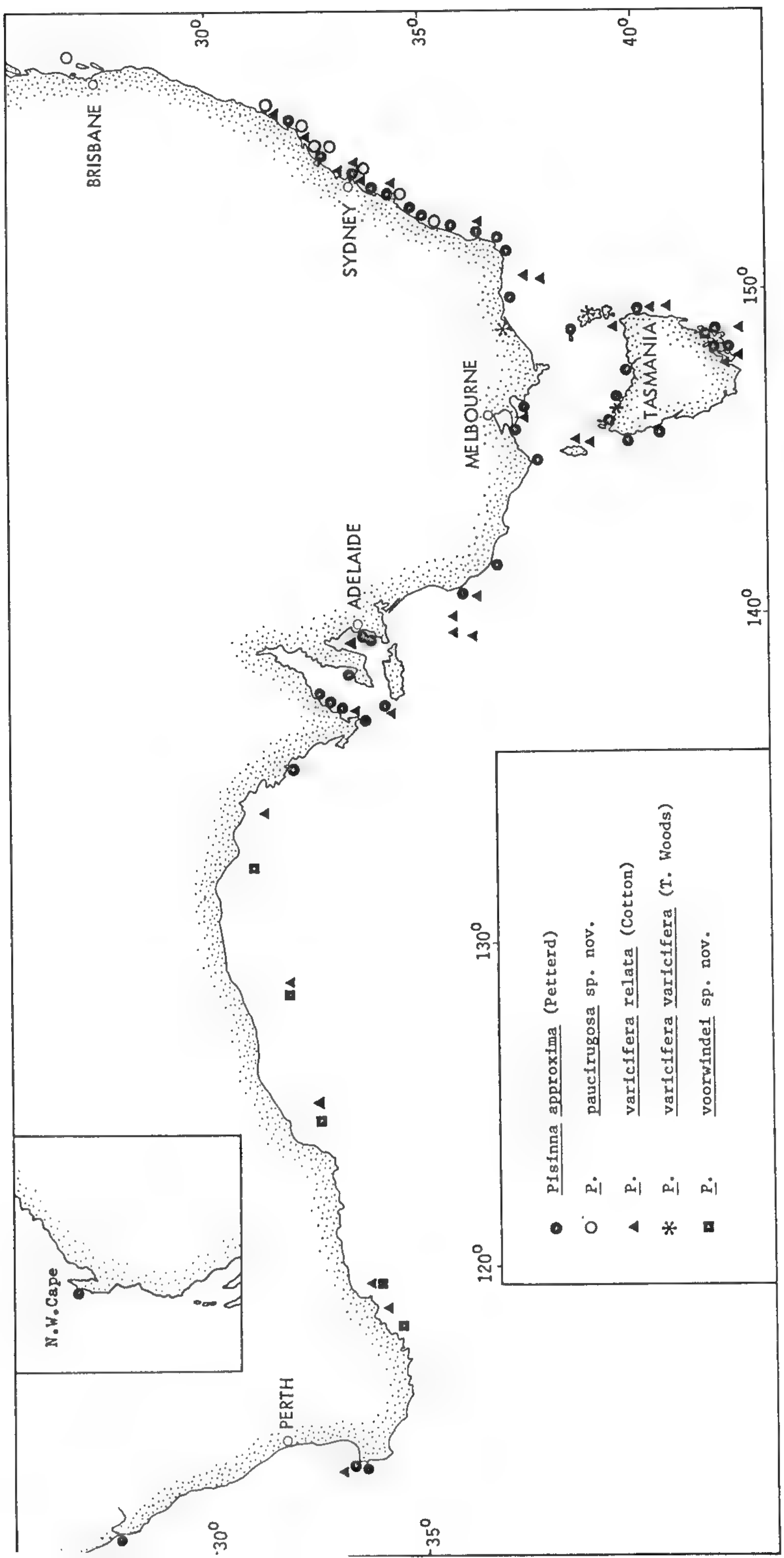

Figure 15. Distribution of the Recent species of *Pisinna*.

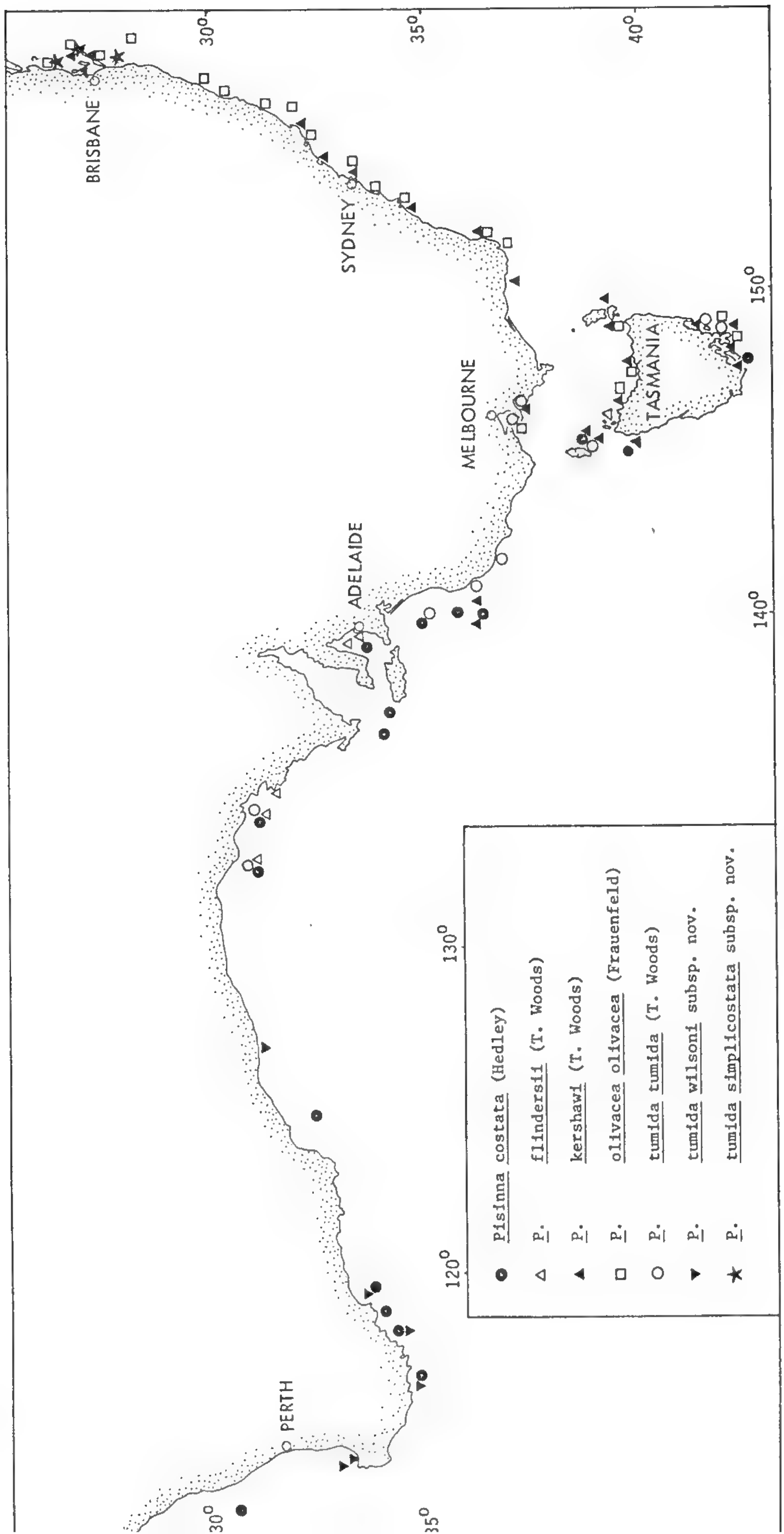

Figure 16. Distribution of the Recent species of *Pisinna*.

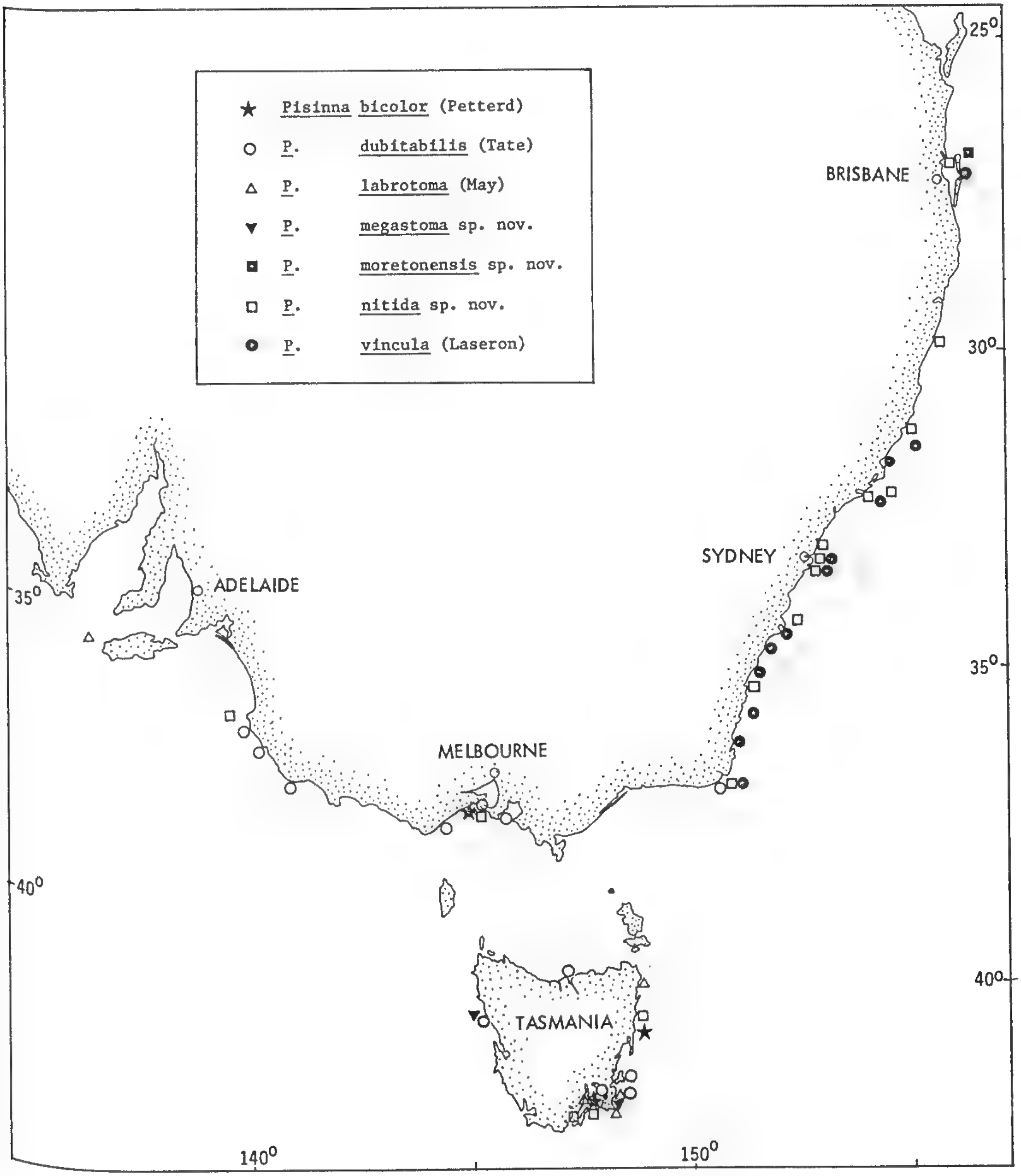

Figure 17. Distribution of the Recent species of *Pisinna*.

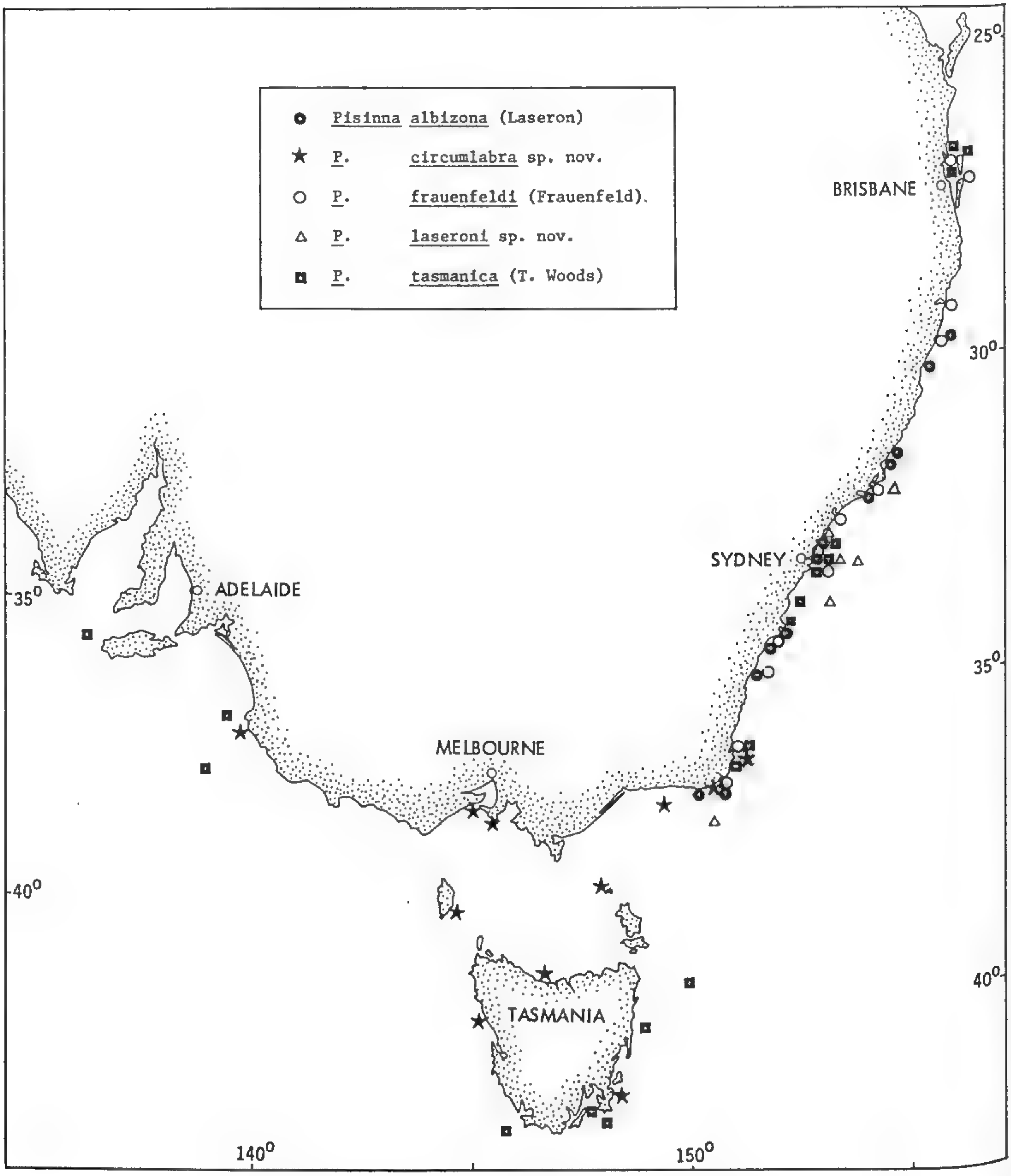

Figure 18. Distribution of the Recent species of *Pisinna*.

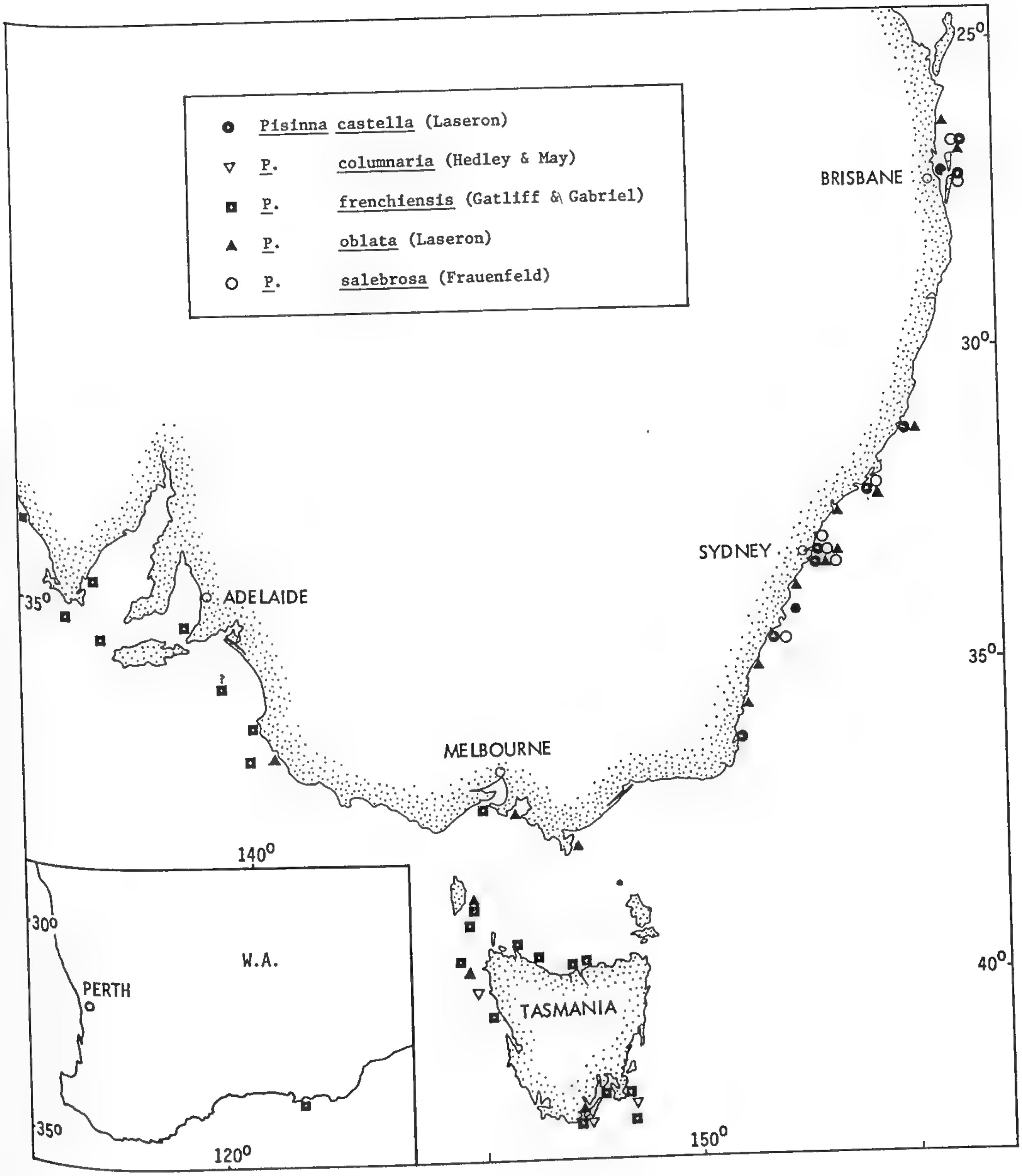

Figure 19. Distribution of the Recent species of *Pisinna*.

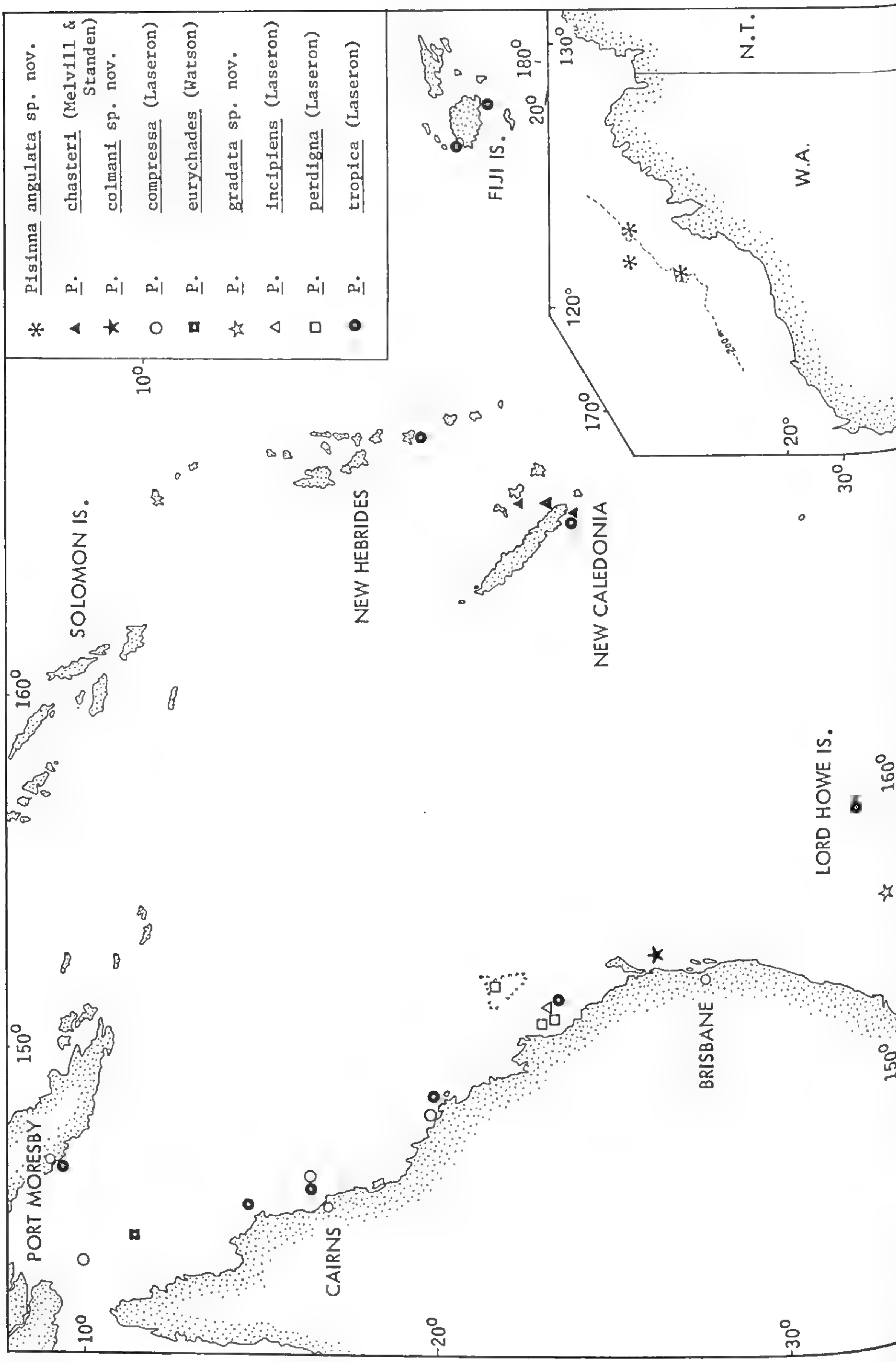

Figure 20. Distribution of the Recent species of Pisinna.

DEEPWATER DECAPOD CRUSTACEA FROM EASTERN AUSTRALIA: BRACHYURAN CRABS

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SUMMARY

Fourteen species of crabs from the lower continental shelf and slope off eastern Australia are discussed. Included are two new species, one belonging to the homolid genus *Homolochunia* (which is also recorded from near New Caledonia) and one belonging to the cymonomid genus *Cymonomus*. The majids *Cyrtomaia suhmi* and *Leptomithrax richardsoni*, the geryonid *Geryon affinis* and the goneplacid *Litocheira kingsleyi* are recorded from Australia for the first time. The new species are described and illustrated.

The deepwater crab fauna of eastern Australia as it is presently known is compared with that of other nearby areas in the Indo-West Pacific.

INTRODUCTION

The deepwater crab fauna of eastern Australia is at present known only from early work by the 'Challenger' (Miers, 1886), the 'Thetis' (Whitelegge, 1900), and 'Endeavour' (Rathbun, 1918, 1923) Expeditions, and from miscellaneous deep hauls (Grant, 1905, etc.). The same is true of South Australia, the work of Baker (1904-1907) being the main contribution.

Since 1971, New South Wales State Fisheries has been carrying out trawling experiments along the coast of New South Wales in relation to the distribution of prawns off the eastern Australian coast (see *Australian Fisheries*, November 1973, pp 24-29). Approximately 60 species of shrimps, lobsters and crabs have been taken during these hauls in depths of 100 to 1,000 metres.

The present paper is a report on the brachyuran crabs collected from 1971 to June 1975. Fourteen species are recorded. The material on which this report is based is in the collection of the Australian Museum, Sydney (AM). Each species account includes principal references, a list of material, localities (all off New South Wales unless otherwise stated), remarks where necessary and a summary of the geographic and bathymetric distribution. Measurements given are carapace length (cl.) or width (cw).

SYSTEMATIC ACCOUNT

Family HOMOLIDAE

Latreillopsis petterdi Grant

Latreillopsis petterdi Grant, 1905: 317-319, pl. 10 figs. 2, 2a, 2b.—Rathbun, 1923: 140-143, pl. 36.—Dell, 1963: 244-245.—Bennett, 1964: 27, fig. 109.—Takeda & Miyake, 1969: 159-161, fig. 1, pl. 1.

Records of the Australian Museum, 1975, **30**, 248-271, Figures 1-10

Paromola petterdi.—Serene & Lohavanijaya, 1973: 26, 27.

MATERIAL: 19♂♂, 6♀♀ (2 ovig.), cl. 16-98.5 mm (AM P. 17963, 17971, 17973-4, 18372, 18997, 19107-12, 19612-16).

LOCALITIES: South east of Grafton, 29°49'S., 153°42'E. to 29°59'S., 153°38'E., 369 m, 12 May 1971, 1 spec. — Off Port Stephens, 32°46'S., 152°46'E. to 32°51'S., 152°42'E., 540 m, 29 April 1971, 5 specs. — Off Newcastle, 33°00'S., 152°31'E. to 32°55'S., 152°36'E., 360 m, July 18, 1972, 7 specs. — 25 miles east of Sydney, 33°39'S., 151°49'E. to 33°50'S., 152°55'E., 270-360 m, 6-7 April 1971, 2 specs. — South of Port Hacking, 34°19'S., 151°24'E. to 34°13'S., 151°28'E., 360 m, prawn trawl, 28 June 1971, 7 specs. — South of Jervis Bay, 35°31'S., 150°45'E. to 35°37'S., 150°42'E., 423-405 m, prawn trawl, 8 July 1971, 3 specs.

REMARKS: This species has been well described by Rathbun (1923) and by Dell (1955). The generic placing was reviewed by Griffin (1965). Following Gordon (1950), Serene & Lohavanijaya (1973) place this species in the genus *Paromola* Wood-Mason & Alcock.

DISTRIBUTION: Southeast coast of Australia, New Zealand; 180-540 m.

Homolochunia kullar[1] n.sp.

Figs 1-3

HOLOTYPE: Female, cl. 61 mm (AM P. 18998), off Sydney, 33°52'S., 152°50'E. to 33°48'S., 152°54'E., 765 m, 7 December 1972.

PARATYPES: Ovigerous female, cl. 58 mm (AM P. 18085), off Broken Bay, 33°34'S., 152°03'E. to 33°43'S., 151°59'E., 558 m, prawn trawl, smooth bottom, 21 April 1971. Male, cl. 60 mm (AM P. 20252), off St. Vincent's Pass, S.W. of New Caledonia, 880 m, 45 ft. pelagic trawl hit bottom, 29 April 1971, J. R. Paxton on R.V. 'Coriolis".

DESCRIPTION: Carapace urn-shaped, convex, longer than wide, greatest width just behind middle; surfaces sparsely spiny, covered by short, dense tomentum, regions moderately well defined.

Medial rostral spine acuminate, dorsally grooved. Supraorbital spines slightly longer than carapace, arcuate, with three dorsal spines, tip bifid, dorsal branch longer than ventral.

Nine spines or tubercles on, or close to, midline of carapace — a pair of prominent submedial protogastrics behind lateral rostral spines, a prominent mesogastric close to posterior margin of region, a pair of metagastric tubercles, a pair of low cardiac tubercles and a pair of low branchial tubercles on each side of the intestinal region.

Six prominent spines laterally on carapace — two subhepatic, the anterior the longest, the posterior at a lower level (and two small tubercles posteriorly), two hepatic (one lateral and one more medial), one anterior branchial and one posterior branchial.

Antennules bulbous basally, two terminal segments short. Antennae reaching as far as middle of supraorbital spine, smooth.

A small spine at origin of antenna laterally. Pterygostomian region with three low spines posteriorly.

Eyestalks comprising slender basal segment and bulbous terminal segment; cornea large, semicircular.

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[1]'kullar' is the word used by the aborigines of the Wadi Wadi tribe of the Illawarra region (Wollongong, south of Sydney) for a long-handled, four-pronged fish spear.

Third maxillipeds subpediform, flattened, unarmed, widest at anterior edge of merus. Ischium subrectangular, with broad shallow, central longitudinal groove. Merus quadrate, broadening slightly to anterior edge. Palp subcylindrical, propodus twice length of carpus, dactyl two-thirds propodus, tapering.

Chelipeds subequal in both sexes, in the male slightly longer than the carapace and supraorbital spines together, slightly shorter in the female, slender, cylindrical to subcylindrical; ischium with two dorsal spines, merus with four spines dorsally in proximal third, proximal two longer and one distally on dorsal edge. Palm of chela inflated, weakly compressed, expanded distally in male, extremely slender in female; fingers 1/3 length of palm, finely toothed cutting edges gaping in male proximally, dactyl with tooth in gape; edges adjacent throughout in female.

Ambulatory legs cylindrical, extremely long and slender, third longest, almost 6 times carapace length, second only a little shorter, the first 4 times carapace length, last leg short, about 1/2 length of first. Meri of first three legs with 6-7 sharp, weakly curved, equally spaced dorsal spines and a terminal spine, remaining segments smooth, dactyls with dorsal fringe of hairs on distal third. Last leg with a distal spine on merus, otherwise smooth; chelate to subchelate, gape slight (see fig. 3b).

Abdomen of 7 segments in male, of 6 segments in female, (fifth and sixth partially fused along a prominent transverse ridge), ovate; a prominent central spine on segments 2-4 and a lateral spine or tubercle on segments 3-5, segment 5 with a central tubercle, segment 6 with a distal medial tubercle or spinule, last segment triangular, unarmed.

Male first pleopod flattened, moderately broad, distally slender and outwardly curved. Second pleopod not much shorter than first, apically truncate.

REMARKS: To the present time only one species of the genus *Homolochunia* Doflein, 1904 has been recorded. *Homolochunia valdiviae* Doflein has been collected off east Africa and Japan (Doflein, 1904; Gordon, 1950, Sakai, 1955).

The genus is distinguished by the following features:

1) the propodus of the fourth ambulatory leg is chelate to subchelate;

2) the supraorbital spine bears sub-apically a prominent spine ventrally so as to appear bifid in the vertical plane.

The new species differs from *H. valdiviae* in two main features:

1) the supraorbital spine is longer (just exceeding the carapace), and bears three spines dorsally in the proximal 2/3, as opposed to two spines (in *H. valdiviae*);

2) the spine or fixed finger on the propodus of the last leg arises distally, not proximally and the 'gape' thus appears narrow, not broad as in *H. valdiviae*.

There also appear to be differences in the number of dorsal spines on the ambulatory meri (6-7 as opposed to 4-6), and the spines of the carapace appear longer and sharper. (The spines on the carapace are usually longer and sharper in juvenile crabs but this is not the case in *H. valdiviae* — the juvenile male figured by Doflein (1904: pl. 1 fig. 2) has short, blunt spines like the adult.) The spines on the lateral part of segment 4 of the abdomen of the female of our specimen are slightly longer than those of *H. valdiviae*.

This genus has not previously been recorded from Australia.

DISTRIBUTION: Off eastern Australia, and New Caledonia; 558-880 m.

Family CYMONOMIDAE

Cymonomus delli[2] n. sp.

Figs 4, 5

HOLOTYPE: Female, cl. 8.9 mm (AM P. 19379), off Sydney, 33°51′S., 151°51′E. to 33°45′S., 151°55′E., 675 m, 19 October 1972.

DESCRIPTION: Body and appendages with granules, spinules and short hairs. Carapace subquadrate, one or two spinules at anterolateral angle enlarged. Regions poorly marked, only intestinal region obvious, a faint line marking border of mesogastric region, a low ridge extending obliquely forward from intestinal region to lateral surface of carapace.

Rostrum short, sharply triangular, unarmed, about half length of eyestalks.

Eyestalks weakly flattened, reaching to end of first segment of antenna, hardly tapering, distally rounded, dorsal surface densely covered by granules and laterally by spinules, ventrally smooth; no vestige of cornea.

Antennules as long as carapace, second segment of peduncle bulbous, other three segments slender. Antennal peduncle reaching middle of third segment of antennular peduncle; antennal scale obsolete.

Third maxillipeds granular, merus of endopod spinulous, exopod reaching almost as far forward as anterior edge of merus of endopod. Merus of endopod about 2/3 length of ischium.

Chelipeds with a few spinules dorsally on carpus and chela, palm of chela with enlarged granules on outer surface; fingers slightly longer than palm, cutting edges only weakly gaping.

First two ambulatory legs long, second three times length of carapace including rostrum, first 2/3 length of second, last two legs subequal, 1.3 times total length of carapace. Dactyls of first two legs at least 1.5 times length of propodus, weakly curved, distally weakly depressed, dactyls of last two legs less than 1/4 length of propodi, curved, weakly compressed.

Sternum granular.

Abdomen of female of seven free segments, segment 7 short and broadly rounded; surface granular, second and third segments with spinules laterally.

REMARKS: We follow I. Gordon (pers. comm. to J. S. Garth) in placing the genus *Cymonomus* A. Milne Edwards, 1880 in a separate family on the basis of the external genitalia.

C. delli, like *C. cubensis* Chace 1940, differs from most other species of the genus in having seven abdominal segments instead of six. In some groups, e.g., spider crabs (family Majidae), differences such as this are considered important enough to warrant subfamiliar separation. Further investigation of the genus *Cymonomus* may result in separation of the species into two or more genera on this basis.

Differences from the New Zealand species *C. aequilonius* Dell, 1971 include the number of segments in the abdomen, the shorter rostrum relative to the eyestalk, the less

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[2]Named for Dr. R. K. Dell, presently Director of the National Museum (of New Zealand), who has contributed much to the knowledge of New Zealand and Australian crabs including the genus *Cymonomus*.

advanced front (extraorbital border). From the New Zealand C. *bathamae* Dell, 1971, it differs in the number of abdominal segments, the weakly advanced front, the presence of spines at the anterolateral corner and the smoother appearance of the carapace.

From C. *andamanicus* Alcock, 1905, C. *delli* differs in having two spinules on the anterolateral angle of the carapace, the smoother appearance of the carapace and legs (number of abdominal segments of C. *andamanicus* unknown).

C. *granulatus japonicus* Balss, 1922a, has a very long rostrum and medially advanced front (number of abdominal segments unknown).

The new species agrees with C. *granulatus curvirostris* Sakai, 1965 in the rostrum being shorter than the eyestalks, but Sakai's species is very strongly granulate, and the granules along the lateral margins are knobby or leaflike; the number of abdominal segments in this species are unknown.

This genus has not previously been recorded from Australia.

DISTRIBUTION: Eastern Australia; 675 m.

Family MAJIDAE

Chlorinoides goldsboroughi Rathbun

Chlorinoides goldsboroughi Rathbun, 1906: 881-882, pl. 14, fig. 7. — Griffin, 1970: 67-70, figs. 1a, 2, 4b, c, f.

MATERIAL: 1♂, cl. 19 mm (AM P. 19643).

LOCALITY: Southeast of Gabo Island, Victoria, 37°39'S., 150°17'E. to 37°45'S., 150°13'E., 401-396 m, 30 July 1971, 1 spec.

REMARKS: Differences between this species and the Japanese C. *brevispinosa* Yokoya have already been discussed recently (Griffin, 1966a, 1970).

DISTRIBUTION: Hawaii; southeastern Australia; 126-401 m.

Cyrtomaia suhmi Miers

Fig 6

Cyrtomaia suhmi Miers, 1886: 16-17, pl. 3, fig. 2. — Griffin 1974: 9-10.

MATERIAL: 1♂, post. rost. 1. 60.0 mm, 4♀♀ (3 ovig.), cl. 69-76 mm (P. 19153, 20585, 20586, 20631), smallest ovig. ♀ 71 mm.

LOCALITIES: Off Port Stephens, 32°46'S., 152°46'E. to 32°51'S., 152°42'E., 540 m, 29 April 1971, 2 specs. — East of Broken Bay, 33°39'S., 151°56'E., to 33°33'S., 152°00'E., 450 m, 8 April 1975, 2 specs; 33°40'S., 151°53'E. to 33°35'S., 151°58'E., 450-810 m, 23 May 1975, 1 spec.

REMARKS: These extremely large specimens are smooth with long protogastric spines. They clearly are not C. *maccullochi* Rathbun, 1918, the only known large Australian *Cyrtomaia*. That species differs in having no spine above the eye (probably not specifically important in this genus), there is a line of close-set tubercles laterally on each branchial region, the surface of the carapace is coarsely granular and there are fewer dorsal branchial spines.

C. *suhmi* is at present considered to contain three subspecies (see Griffin, 1974; and Serene & Lohavanijaya, 1973). One of these, the Japanese C. *suhmi curviceros* Bouvier, 1916, resembles our five specimens in its large size, the arrangement of spines on the carapace, the generally smooth appearance, the relative length and shape of the rostrum and the

ornamentation of the basal antennal article. The Japanese species, however, lacks a spine above the eye (present in all of our specimens) and possesses two subdorsal branchial spines, instead of one. It seems almost certain that *C. suhmi curviceros* is not subspecifically distinct from *C. suhmi suhmi*.

There are four other large species of *Cyrtomaia*. *C. echinata* Rathbun, 1916, from the Philippines is extremely spiny. *C. horrida* Rathbun, 1916, from the Philippines has a spine on the orbital border but the anterolateral branchial spines are much larger than on our specimens, there is an intestinal spine (absent in our specimens) and two mesogastric spines (only one in our specimens).

C. goodridgei McArdle, 1900, from the Indian Ocean differs in having spinules along the anterior border of the branchial region dorsally, there is a strong ridge extending back from each orbit to each large protogastric spine, there is no spine above the eye, there is only one spine on the lateral edge of the basal antennal article and the erect protogastric spines are longer than the branchial spines.

The New Zealand *C. hispida* (Borradaile, 1916) is a small species (Bennett, 1964).

Cyrtomaia suhmi has not previously been recorded from Australia.

DISTRIBUTION: Indo-West Pacific, northern Indian Ocean, Indonesia, Philippine Islands and Japan; southeastern Australia; 450-900 m.

Leptomithrax richardsoni Dell

Leptomithrax richardsoni Dell, 1960: 2-4, fig. 3, pl. 2. — Dell, 1963: 252 (in list). — Griffin, 1966b: 79-81, figs. 16, 23, pls. 3, 4. — Takeda & Miyake, 1969: 184-5.

MATERIAL: 1♂, cl. 70 mm, 1♀, (post. rost.) cl. 53.5 mm (AM P. 18367, 20668).

LOCALITIES: Southeast of Broken Bay, 33°40'S., 151°55'E. to 33°35'S., 151°58'E., 540 m, 14 July 1971, 1 spec. — East of Brush Island, 35°28'S., 150°48'E. to 35°34'S., 150°45'E., 540-558 m, 10 June 1975, 1 spec.

REMARKS: These two specimens clearly agree with specimens from New Zealand in the characteristic features of the orbit, chelipeds and first pleopod.

This species has not been previously recorded from Australia.

DISTRIBUTION: New Zealand; southeastern Australia; 382-558 m.

Leptomithrax waitei (Whitelegge)

Chlorinoides waitei Whitelegge, 1900: 143-146, pl. 33.

Leptomithrax waitei. — Rathbun, 1918: 23. — Griffin, 1966c, p. 285 (in key).

MATERIAL: 2 ovig. ♀♀, cl. 120.5 mm, 113.5 mm (AM P. 18598).

LOCALITY: Southeast of Broken Bay, 33°40'S., 151°55'E. to 33°35'S., 151°58'E., 540 m, 14 July 1971, 2 specs.

REMARKS: This species is well described and figured by Whitelegge.

DISTRIBUTION: Southeastern Australia, lower shelf and slope to 540 m.

Rochinia fultoni (Grant)

Hyastenus fultoni Grant, 1905: 313-315, pl. 11, fig. 1.

Scyramathia fultoni. — Rathbun, 1918: 14, pl. 5.

Rochinia fultoni. — Griffin, 1972: 71-72. — Serene & Lohavanijaya, 1973: 55 (in key).

MATERIAL: 2♂♂, 1 ovig. ♀, cl. 21-26.5 mm (AM P. 17965, 18990-1).

LOCALITIES: Off Port Stevens, 32°46'S., 152°46'E. to 32°51'S., 152°42'E., 585-576 m, 7 May 1971, 1 spec. — Off Sydney, 33°44'S., 151°48'E. to 33°38'S., 151°45'E., dredged, 270 m, 10 August 1972, 1 spec. — South of Sydney, 34°00'S., 151°43'E. to 33°54'S., 151°47'E., 720 m, 6 November 1972, 1 spec.

REMARKS: This species is most similar to the Japanese *R. debilis* Rathbun from which it differs in possessing a conical mesogastric spine; it also possesses a much longer intestinal spine and a small tubercle on each side of the cardiac spine.

DISTRIBUTION: Southeastern Australia; 108-720 m.

Family PORTUNIDAE

Ovalipes molleri (Ward)

Aeneacancer molleri Ward, 1933: 381-3, pl. 23, fig. 11.

Ovalipes molleri. — Stephenson and Rees, 1968: 237-239, pls 37A, 40B, 41B, 42H; figs. 1H, 29, 39, 4G. — Dawson & Yaldwyn, 1974: 46-47.

MATERIAL: 4♂♂, 11♀♀ (2 ovig.), cw. 31-87.5 mm (AM P. 17912-3, 17969, 17972, 19100-1, 19611).

LOCALITIES: Off Port Stephens, 32°46'S., 152°46'E. to 32°51'S., 152°42'E., 585-576 m, 7 May 1971, 5 specs; 32°54'S., 152°37'E., to 32°50'S., 152°42'E., 369-360 m, prawn trawl, mud bottom, 28 April 1971, 2 specs. — Between Port Stephens and Lake Macquarie, 32°46'S., 152°17'E. to 33°15'S., 152°46'E., 360-540 m, 28-29 April 1971, 2 specs. — Transect between Port Stephens and Sydney, 32°51'S., 151°48'E. to 33°47'S., 152°45'E., 360 m, July 1972, 3 specs. — 25 miles east of Sydney, 33°39'S., 151°49'E. to 33°50'S., 152°55'E., 80 ft. otter trawl, 270-360 m, 6-7 April 1971, 2 specs. — South of Port Hacking, 34°15'S., 151°25'E. to 34°20'S., 151°21'E., 261-279 m, 28 June 1971, 1 spec.

REMARKS: This species differs from *Ovalipes iridescens* (Miers, 1886) in having four frontal lobes (medial two fused basally) instead of three (see Stephenson & Rees, 1968). There are additional differences in the form of the ridge on the pterygostomian region, the number of spines on the palm of the chela, and the stoutness and hairyness of the first pleopod of the male.

DISTRIBUTION: New Zealand; southeast Australia — off New South Wales and Victoria; 198-585 m.

Family GONEPLACIDAE

Carcinoplax victoriensis Rathbun

Carcinoplax victoriensis Rathbun 1923: 101-103, pl. 19. — Dell, 1960: 4, pl. 1; 1963: 251-252. — Takeda & Miyake, 1969: 172-173. — Şerene & Lohavanijaya, 1973: 64 (in key).

MATERIAL: 15♂♂, 5♀♀, cw. 15-23 mm (AM P. 19143-6, 17915, 17994)

LOCALITIES: Off Broken Bay, 33°41'S., 151°55'E. to 33°44'S., 151°53'E., 540 m, prawn trawl, 20 April 1971, 1 spec. — North of Sydney, 33°44'S., 151°55'E. to 33°40'S., 151°58'E., 720 m, 9 November 1972, 12 specs. — Off Sydney, 33°51'S., 151°51'E. to 33°45'S., 151°55'E.,

675 m, 19 October 1972, 1 spec.; 33°52'S., 152°50'E. to 33°48'S., 152°54'E., 765 m, 7 December 1972, 1 spec. — South of Sydney, 34°00'S., 151°43'E. to 33°54'S., 151°47'E., 720 m, 6 November 1972, 4 specs. — Off Ulladulla, 35°25'S., 150°50'E. to 35°29'S., 150°48'E., 540 m, 2 August 1971, 1 spec.

REMARKS: This species is most easily distinguished from the other Australian species of the genus, *C. meridionalis* Rathbun, 1923, by the dark brown (fading in alcohol) fingers (black in *C. meridionalis*) and the blunt first anterolateral tooth of the carapace.

DISTRIBUTION: Southeastern Australia; New Zealand; 125-765 m.

Carcinoplax meridionalis Rathbun

Carcinoplax meridionalis Rathbun, 1923: 99-101, pl. 19. — Serene & Lohavanijaya, 1973: 67, pl. 15D.

MATERIAL: 1 ♀ (ovig.), cw. 14.5 mm (AM P. 20634).

LOCALITY: East of Wollongong, 34°18'S., 151°26'E. to 34°24'S., 151°23'E., 450-468 m, 29 May 1975, 1 spec.

DISTRIBUTION: Off southeastern Australia, from Eucla, Great Australian Bight to off Wollongong, New South Wales; 126-540 m.

Neopilumnoplax heterochir (Studer)

Pilumnus heterochir Studer, 1882: 11, pl. 1, figs. 3a-d (not seen).

Pilumnoplax heterochir. — Rathbun, 1923: 99, pl. 17, figs. 1, 2.

Neopilumnoplax heterochir. — Serene & Lohavanijaya, 1973: 69-70, pl. 16D.

MATERIAL: 1 ♂, cw. 9.5 mm (AM P. 20635).

LOCALITY: East of Wollongong, 34°18'S., 151°26'E. to 34°24'S., 151°23'E., 450-468 m, 29 May 1975, 1 spec.

REMARKS: This species possesses the uneven carapace, notched front, two anterolateral spines behind the low external orbital spine and bifid or double spine on the medial border of the carpus of the cheliped characteristic of this species. The genus *Neopilumnoplax* Serene (in Guinot, 1969) was set up following the transfer of several species of *Pilumnoplax* to other genera.

DISTRIBUTION: South Africa; South China Sea; southeastern Australia; 108-520 m.

Litocheira kingsleyi (Miers)[3]

Litocheira kingsleyi Miers, 1886: 232-3, pl. 21, fig. 1. — Doflein, 1904: 121. — Tesch, 1918: 164 (in key). — Barnard, 1950: 294-5, fig. 55.

MATERIAL: 1 ♂, 1 ♀ (ovig.), cw. 9.5 mm (AM P. 20671).

LOCALITY: East of Brush Island, 35°28'S., 150°48'E. to 35°34'S., 150°45'E., 459-441 m, 10 June 1975, 2 specs.

REMARKS: This species has been well described and figured by Miers (1886) and Barnard (1950). It is easily distinguished from *L. bispinosa* Kinahan, 1858, the only other

[3]Since this paper was submitted for publication, Türkay, 1975 (*Senckenbergiana biol.* 56(1/3): 103-122) has revised the genus *Litocheira*. *L. kingsleyi* is now placed in the genus *Euchirograpsus*, family Grapsidae.

Australian species of the genus, by the prominent spiniform tooth at the outer angle of the orbit, the shape of the male first pleopod, and the form of the front of the carapace (see McCulloch, 1913).

This species has not previously been recorded from Australia.

DISTRIBUTION: South Africa; southeastern Australia; 171-459 m.

Family GERYONIDAE[4]

Geryon affinis A. Milne Edwards & Bouvier

Figs 7-9

Geryon affinis A. Milne Edwards & Bouvier, 1894: 41-45, figs. A, C, pl. 1, fig. 1. — Alcock, 1899: 85. — Doflein, 1904: 106-111, pls 3, 4, 33, 34, 38, figs. 1-6, pl. 41, figs. 3-7, pl. 43, figs. 2, 8. — Chace, 1940: 39-40. — Kjennerud, 1967: 193-197.

Geryon trispinosus. — Ortmann, 1894: 685-687. — Sakai, 1939: 561; 1965: 168, pl. 82. — Balss, 1922b: 121. (Not *Cancer trispinosus* Herbst, 1803.)

MATERIAL: 10♂♂, 3♀♀ (1 ovig.), cw. 125-175.5 mm (AM P. 19104-6, 19335, 19584-5, 20487-89, 20490-1, 20632-3.)

LOCALITIES: South east of Grafton, 29°49′S., 153°42′E. to 29°59′S., 153°38′E., 369 m, 12 May 1971, 2 specs. — East of Broken Bay, 33°40′S., 151°53′E. to 33°22′S., 152°09′E., 450 m, 19-20 September 1972, 1 spec.; 33°38′S., 151°57′E. to 33°34′S., 152°01′E., 774-792 m, 2 April 1975, 5 specs; 33°40′S., 151°53′E. to 33°35′S., 151°58′E., 450-810 m., 23 May 1975, 2 specs. — North of Sydney, 33°43′S., 151°55′E. to 33°37′S., 152°02′E., 675 m, 19 October 1972, 1 spec. — Off Sydney, 33°52′S., 152°50′E. to 33°48′S., 152°54′E., 765 m, 7 December 1972, 2 specs.

REMARKS: These thirteen specimens all possess four frontal spines, of which the external pair form the internal angle of the orbits and the median two are close together but separated by a broad sinus and project slightly more forward than the external ones. All have five spines on the anterolateral margin of the carapace, the first, third and fifth being the most prominent. The second spine, slightly smaller than the first, is situated less than half way between the first (external orbital border) and third spine. The fourth spine is located approximately equidistant between the third and fifth spines. (In several specimens the fourth spine is not very pronounced.) The ambulatory dactyls are long, slender, compressed and prominently ridged (see A. Milne Edwards and Bouvier).

All the specimens are light yellowish-tan in colour with red markings on the carapace and pereopods as figured by Doflein (1904, pl. 4) except for one juvenile male (cw. 125.0 mm.) in which the carapace is reddish tan in colour.

The specimens figured by Sakai (1965) as *Geryon trispinosus* also have four frontal spines and five anterolateral spines on the carapace. But *Cancer trispinosus*, as originally described and figured by Herbst (1803: 43-44, pl. 57, fig. 4), has only three anterolateral spines. De Man (1890), in giving a description of the Herbst specimen, states "... in the original specimen of Herbst the lateral margin is quite straight between the first and second spines and slightly convex between the second and third spines." Dr. H. E. Gruner

[4]We follow Guinot, 1969 (*Bull. Mus. Nat. Paris* 41 (3): 690-696) and Balss, 1957 (Decapoda. In: Bronns, H. G., Klassen und Ordnungen des Tierreichs, vol. 5 sect. 1 book 7 pt.12, p. 1654, fig. 1196), in placing *Geryon* in a separate family — Geryonidae. Eschscholtz, 1829 (System der Acalephen, p. 86-87, Ferdinand Dümmler, Berlin) however, has used the family name Geryonidae for a group of coelenterates. But the coelenterate family name, Geryonidae, was derived from the genus *Geryonia*, and thus is incorrectly formed; it should be spelt Geryoniidae.

(Zoologisches Museum, Berlin) has kindly forwarded photographs (see fig. 10) of Herbst's type material (from "Ostindien", i.e. Indonesia according toGruner) which confirms that *Cancer trispinosus* processes only three anterolateral spines and lacks ridges on the short ambulatory dactyls.

Barnard (1950), Capart (1951) and Monod (1956) considered *G. affinis* to be a synonym of *G. quinquedens* Smith (1880) on the basis that the ridges on the dactyls, an important diagnostic character used to separate the two species, was not consistant.

G. quinquedens is considered to differ from *G. affinis* in having broad compressed ambulatory dactyles (see Chace, 1940, p. 40) and in being blood red in colour. However, as Sankarankutty (1968) has pointed out, the male first pleopod of *G. quinquedens* figured by Barnard (1950: fig. 54, i) does not possess the prominent pubescence along the lateral margin which is very evident in the pleopod of *G. affinis* (as figured by Doflein, 1904: pl. 41, fig. 6). The New South Wales specimens are also pubescent on the outer margin of the first pleopod of the male (see figs. 9 a-c). A closer examination of all *G. quinquedens/affinis* material is necessary to determine the validity of the difference in the pubescence of the first pleopod of the male.

Of the remaining species, *Geryon tridens* Kroyer, 1836 has three anterolateral spines on the carapace and the male first pleopod, as figured by Sankarankutty (1968), has very thick pubescence on its medial and lateral margins. Barnard (1950) suggests that *Geryon ishurodous* Stebbing, 1923 is probably a synonym of Herbst's *G. trispinosus*. As *G. trispinosus* appears similar to *G. tridens* in the rather straight front and three anterolateral teeth, a closer examination of the male first pleopods of these species is also needed.

This genus has not been recorded previously from Australia.

DISTRIBUTION: Atlantic: Azores, off South Africa, Northern Europe, off eastern North America. Indo-West Pacific: off east Africa, India, Japan and eastern Australia; 80-2000 m.

DISCUSSION

Approximately thirty species of crabs (5% of the total known from Australia — see Griffin & Yaldwyn, 1968) have been recorded from the continental slope (or archibenthal region) of Australia. The families and genera represented in the Australian archibenthal fauna are much the same as those represented in the equivalent faunas of other parts of the Indo-West Pacific. Thus the typical groups are homolids (e.g. *Homola*), dromiids and majids (e.g. *Platymaia, Cyrtomaia* and *Leptomithrax*) and goneplacids (e.g. *Carcinoplax*). But the Australian fauna, as currently known, presents some peculiarities. Deepwater faunas are generally considered to comprise widely distributed species and genera and to contain fewer species with a relatively restricted distribution. Thus the fact that species like *Homola orientalis* Henderson, 1888, *Lyreidus tridentatus* De Haan, 1841, *Platymaia wyvillethomsoni* Miers, 1886, *Cyrtomaia suhmi, Pilumnus tomentosus* Latreille, 1825 and *Geryon affinis* occur in Australia and Japan and, in some cases, in other parts of the Indo-West Pacific, conforms with this general view. But the fact that species of *Cymonomus* and of *Trichopeltarion* (see Dell, 1968), quite distinct from the New Zealand species, should occur in Australia and that other species known from the New Zealand archibenthal, such as *Paromola spinimana* Griffin, 1965, do not occur in Australia suggests an absence of faunal interchange over a much longer period than is sometimes thought. It may further support the suggestion that Australia and New Zealand have been separate and distinct outliers of the tropical Indo-Pacific for a considerable length of time. Further evidence of this may be provided by the study of other deepwater decapod Crustacea.

ACKNOWLEDGEMENTS

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Manuscript received 27 February, 1975. Manuscript revised 10 June, 1975

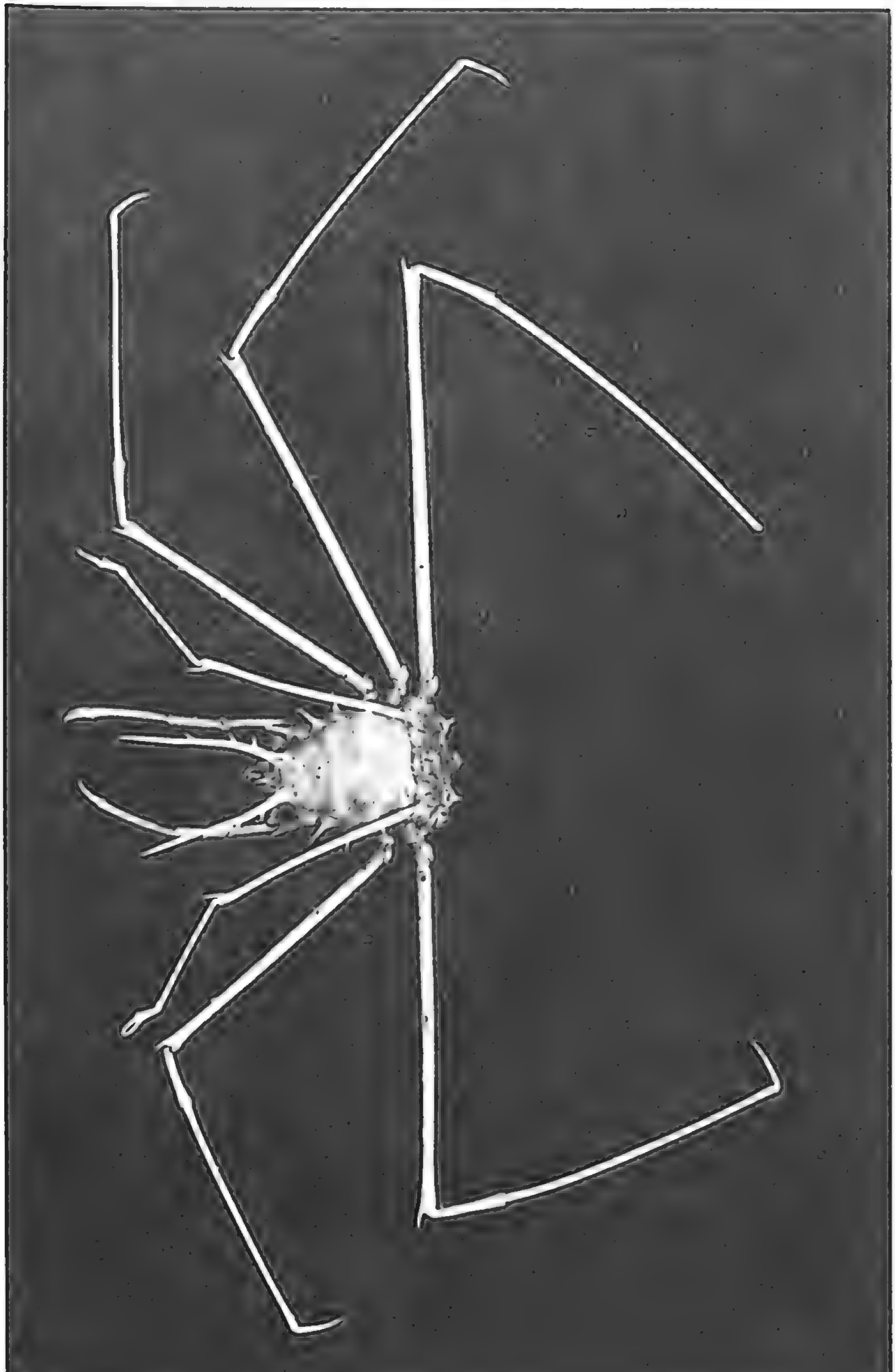


Fig. 1. *Homolochunia kullar* n. sp., female (Holotype, AM P. 18998), cl. 61 mm: dorsal aspect.

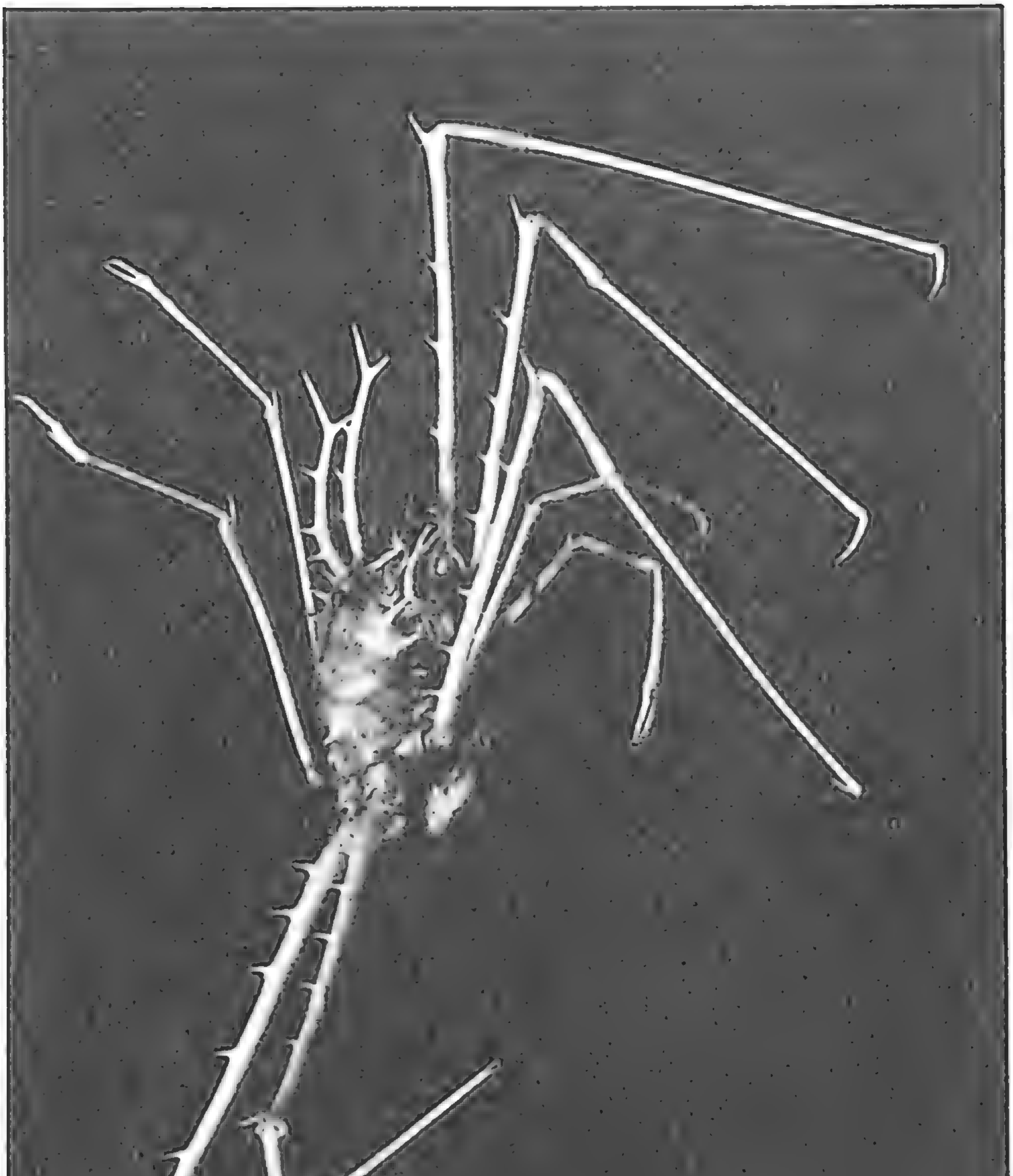


Fig. 2. *Homolochunia kullar* n. sp., female (Holotype, AM P. 18998), cl. 61 mm: lateral aspect.

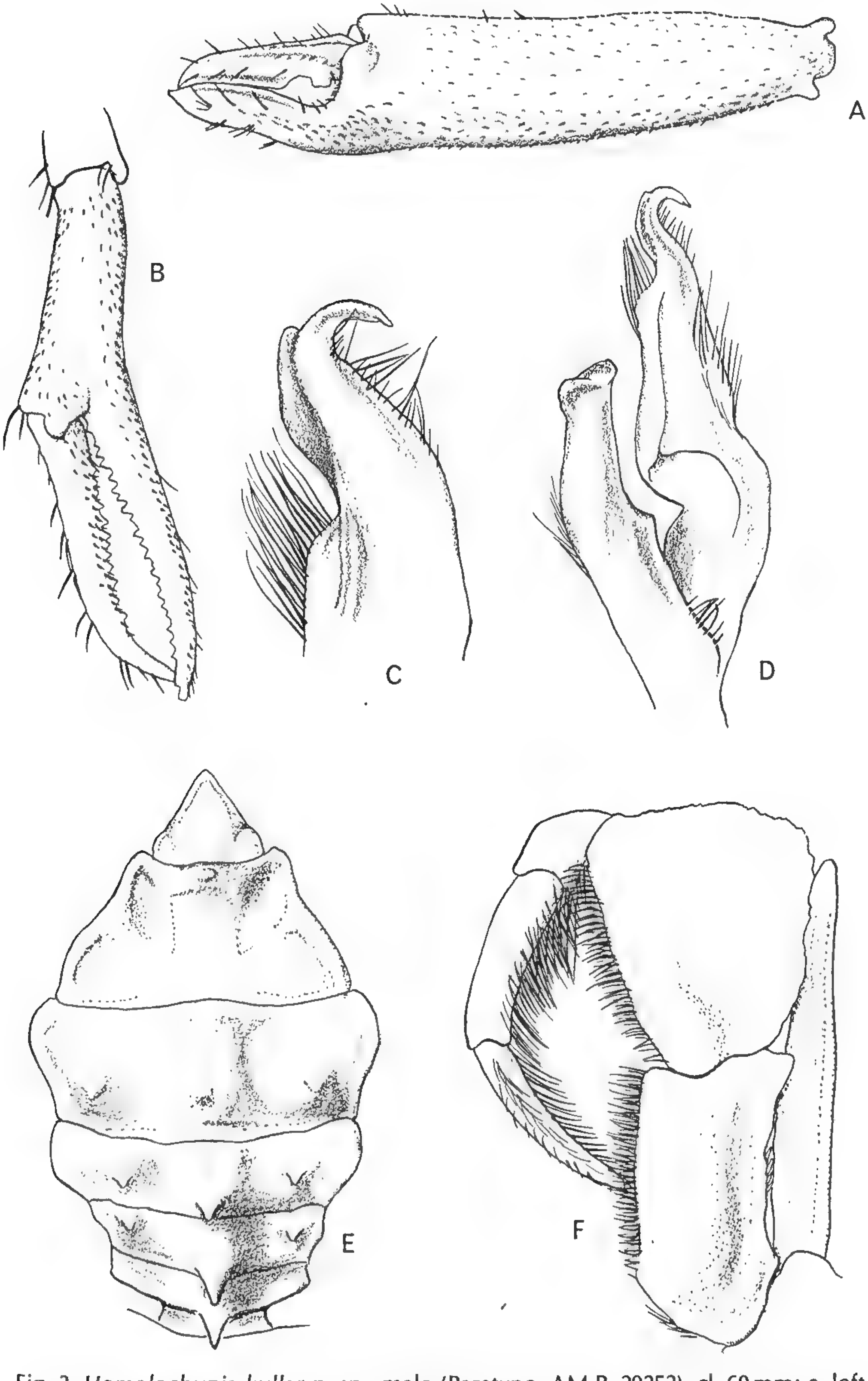


Fig. 3. *Homolochunia kullar* n. sp., male (Paratype, AM P. 20252), cl. 60 mm: a, left chela, outer aspect; b, left fourth ambulatory dactyl, posterior aspect; c, left first pleopod, abdominal aspect; d, left first and second pleopods, abdominal aspect; e, abdomen; f, left third maxilliped.

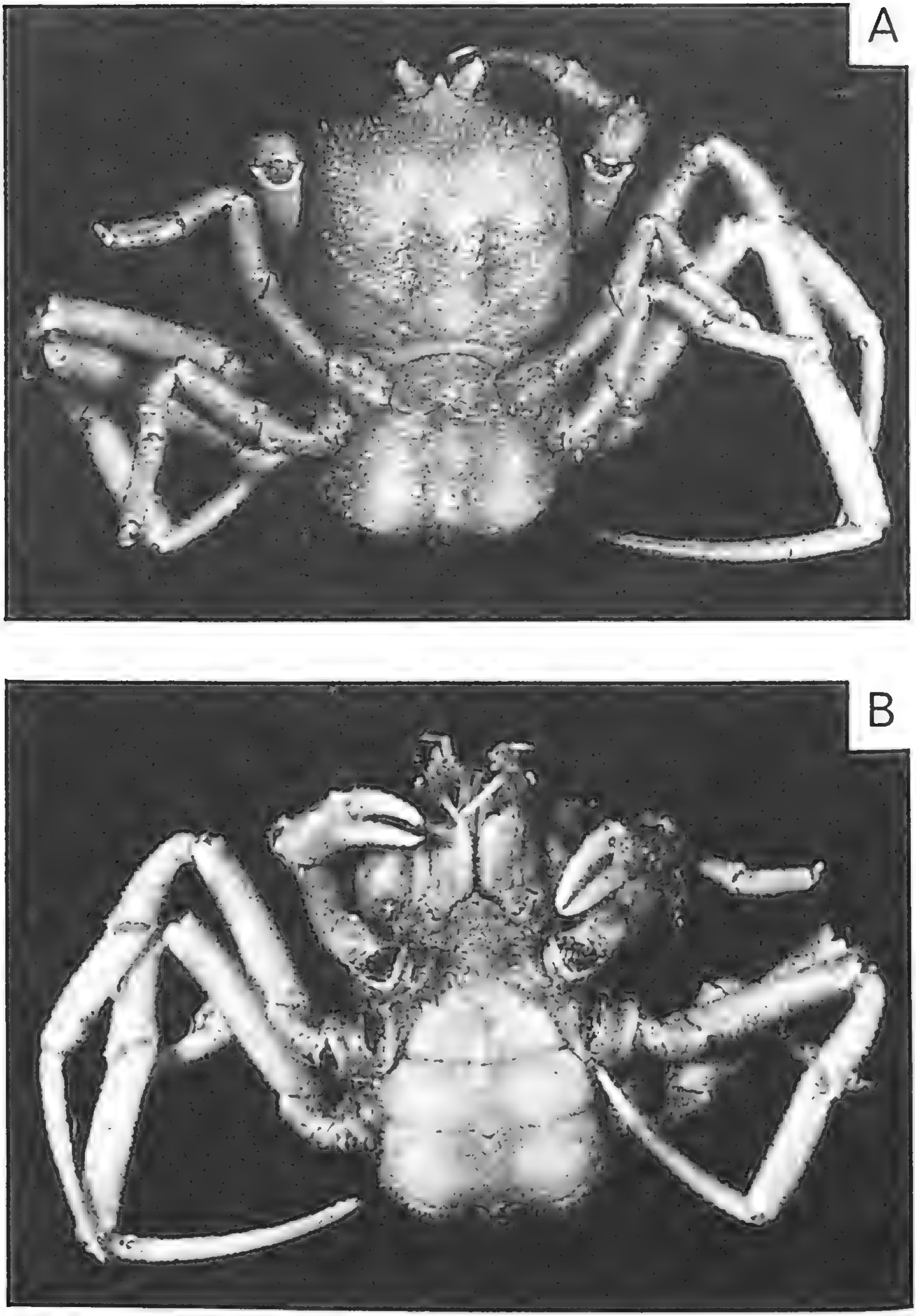


Fig. 4. *Cymonomus delli* n. sp., female (Holotype AM P. 19379), cl. 8.9 mm: a, dorsal aspect; b, ventral aspect.

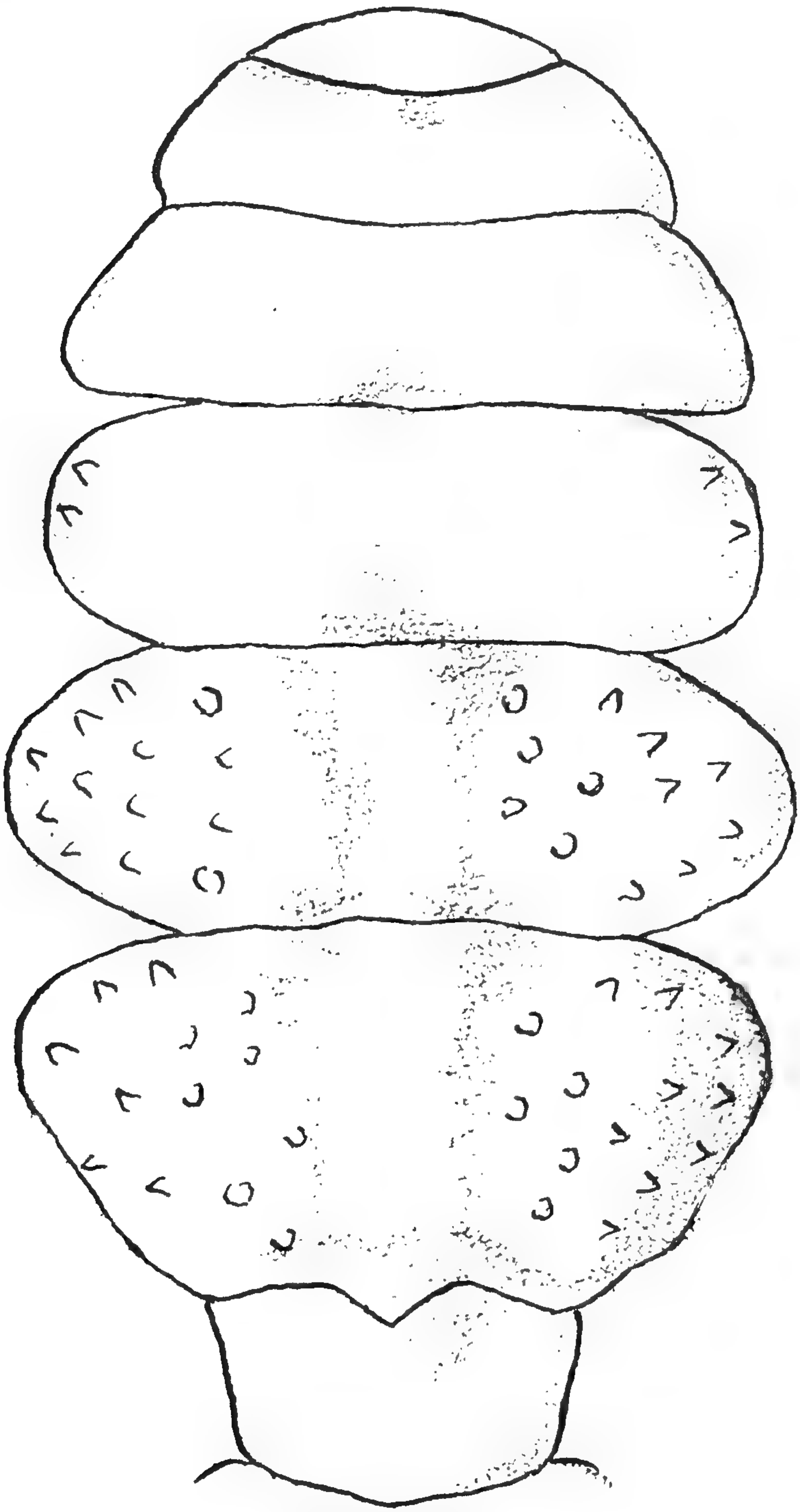


Fig. 5. *Cymonomus delli* n. sp., female (Holotype AM P. 19379), cl. 8.9 mm: abdomen.

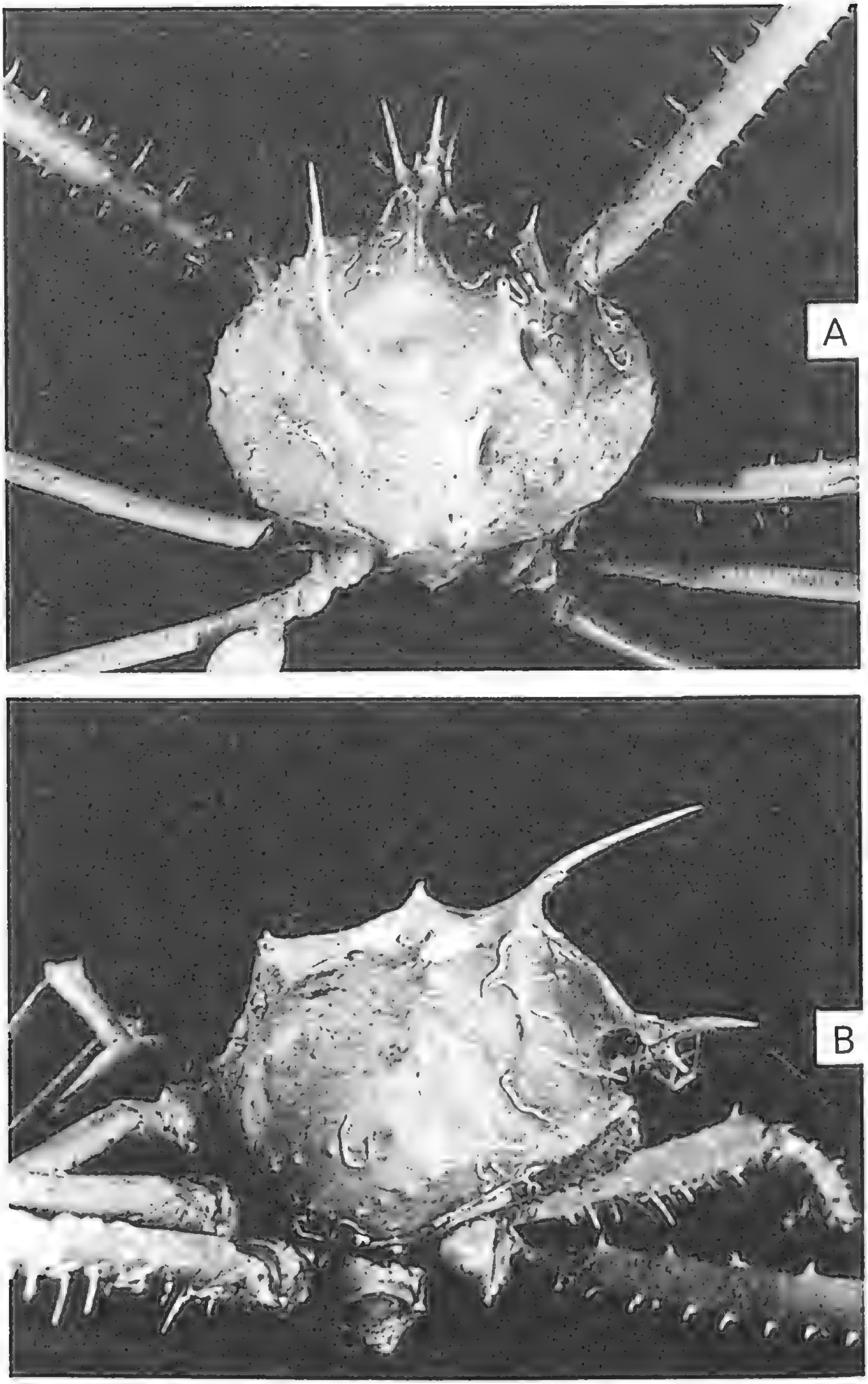


Fig. 6. *Cyrtomaia suhmi* Miers, female (AM P. 20585), cl. 76 mm: a, dorsal aspect; b, lateral aspect.

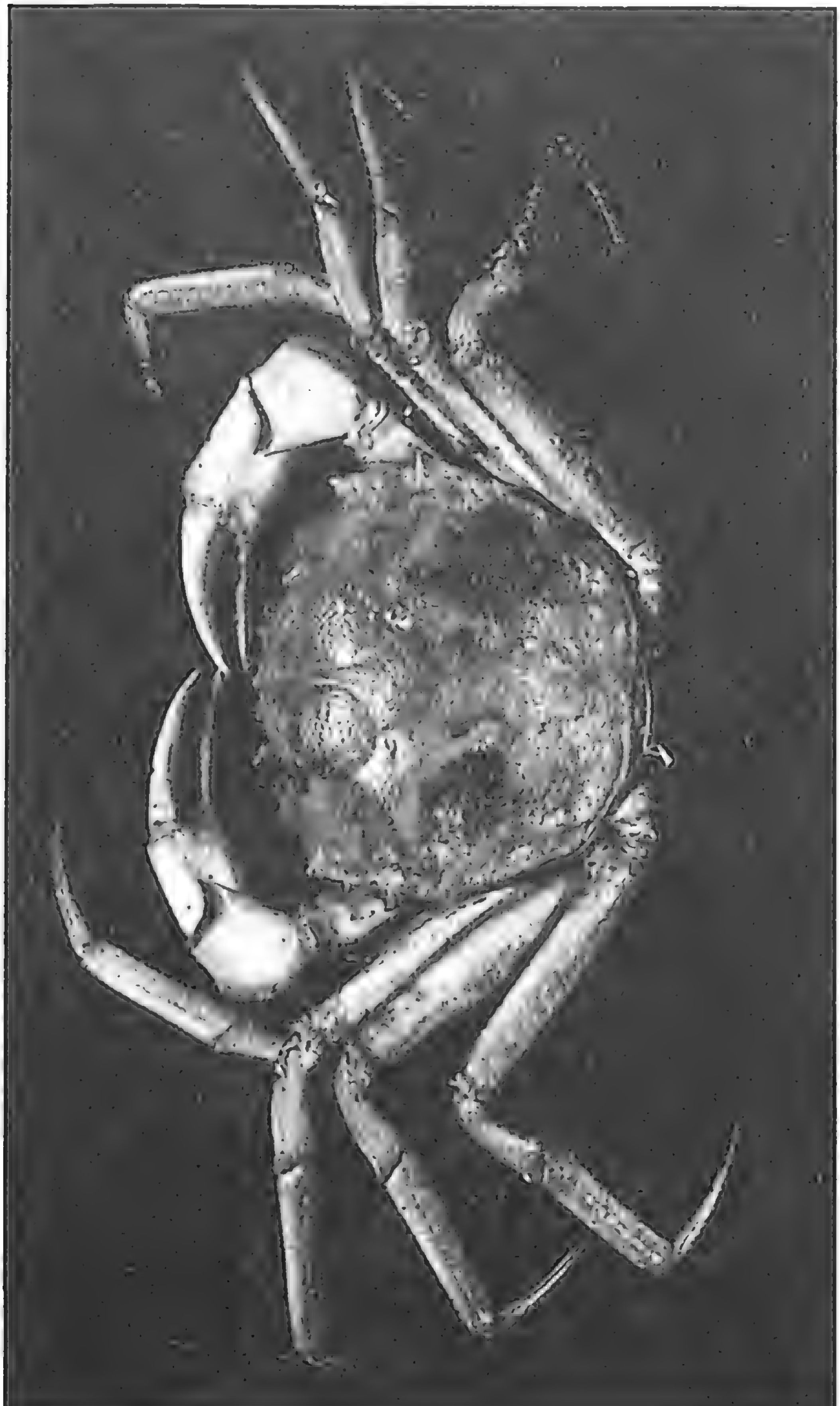


Fig. 7. *Geryon affinis* A. M. Edwards and Bouvier, male (AM P. 19584), cw. 146 mm: dorsal aspect.

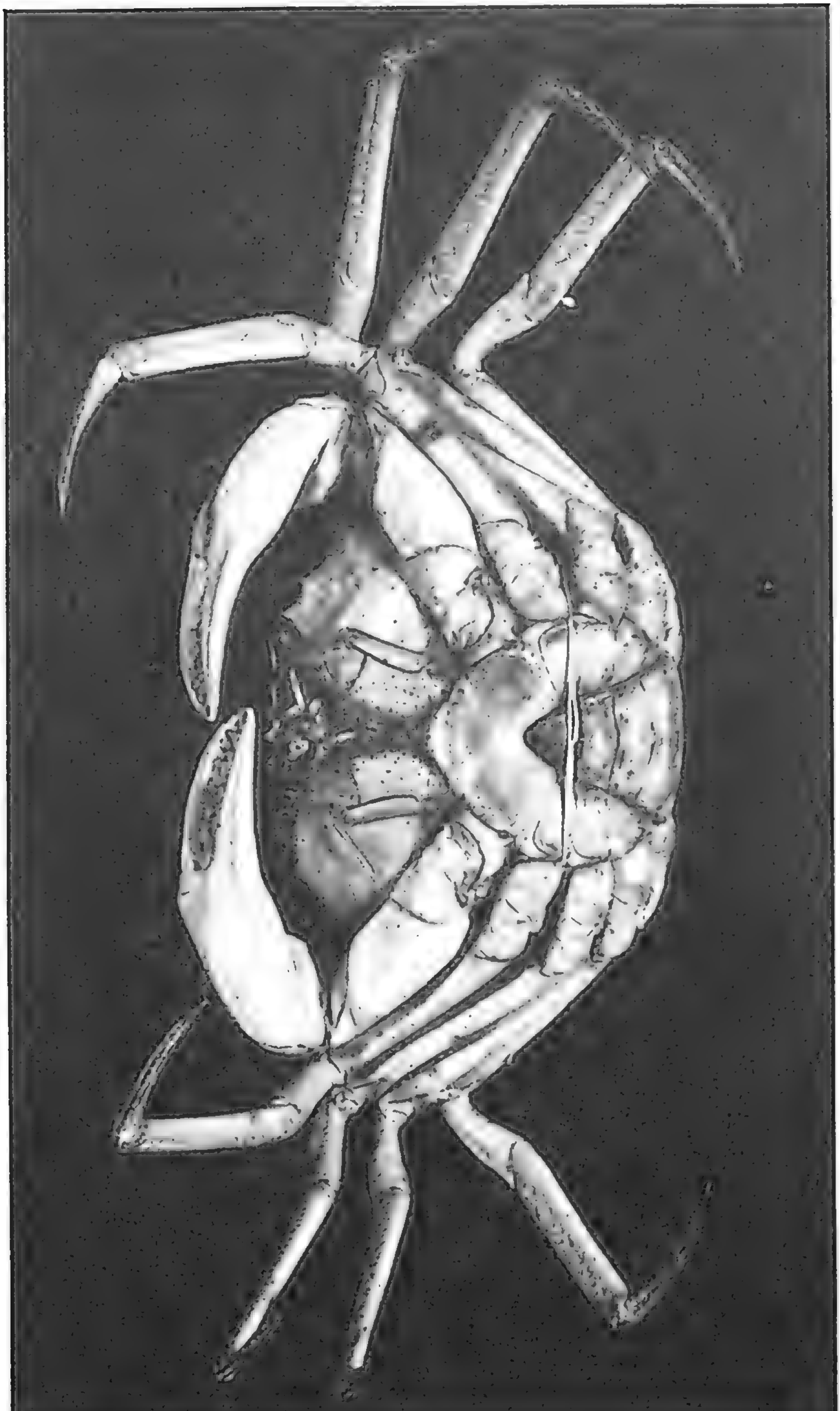


Fig. 8. *Geryon affinis* A. M. Edwards and Bouvier, male (AM P. 19584), cw. 146 mm: ventral aspect.

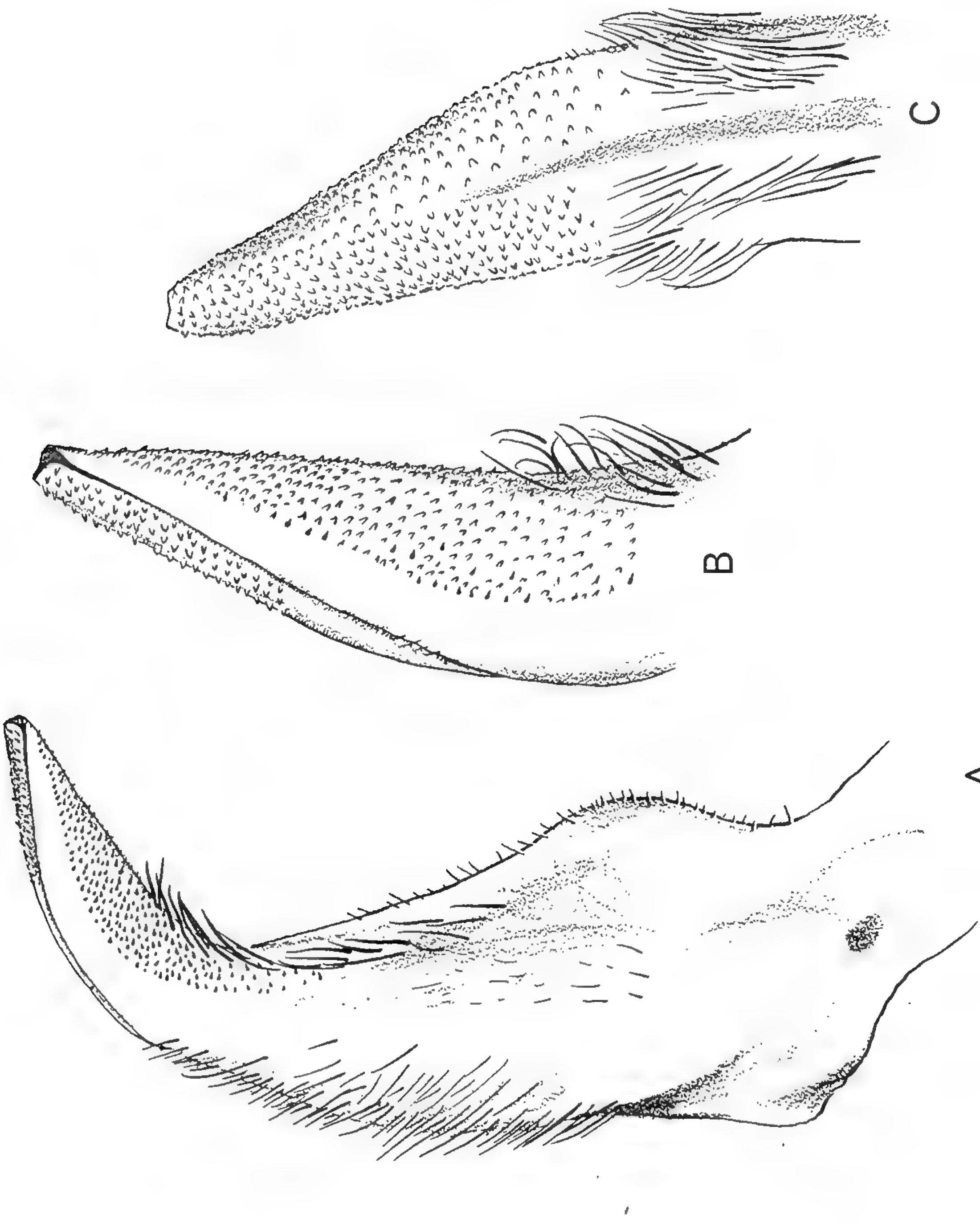
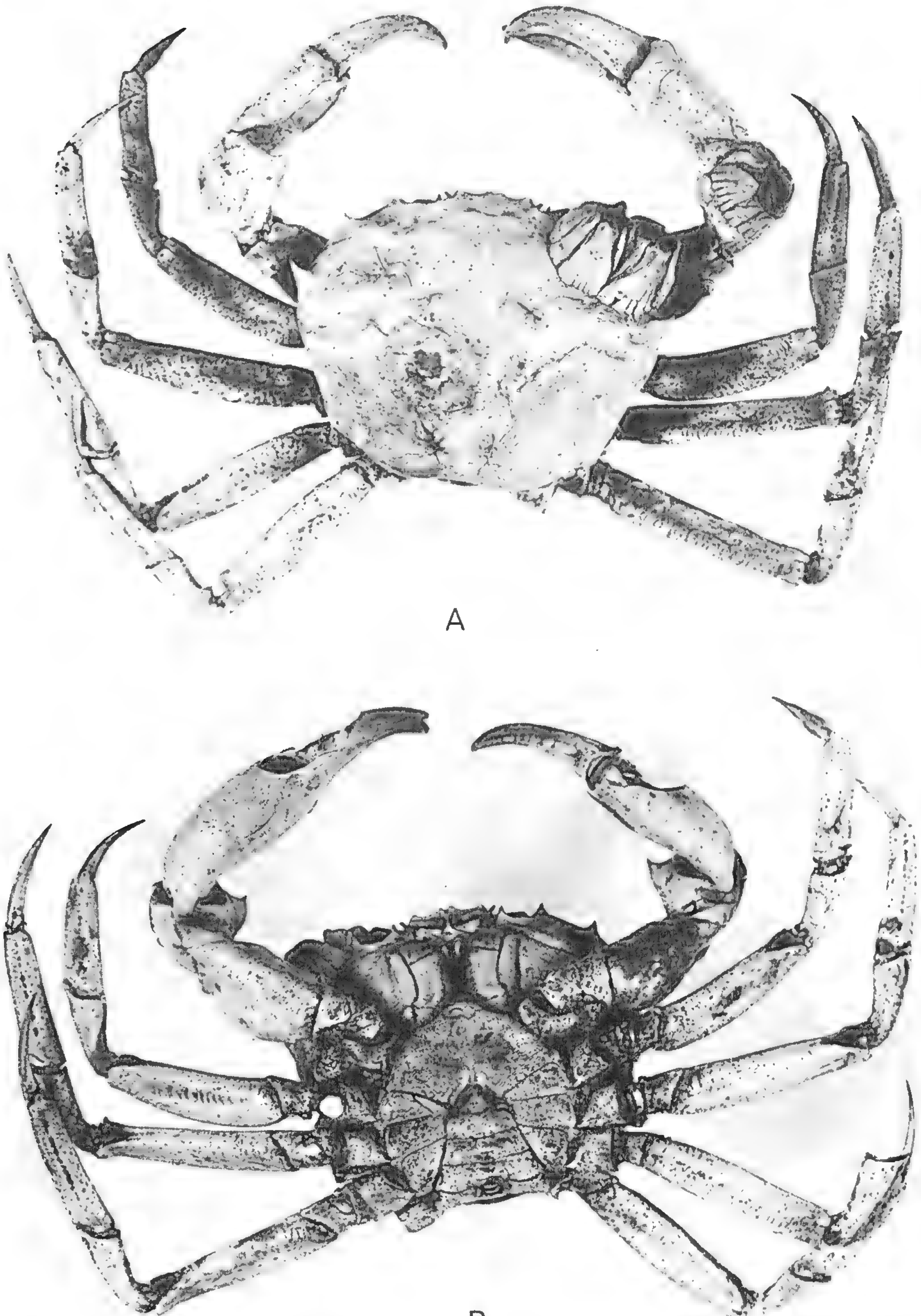


Fig. 9. *Geryon affinis* A. M. Edwards and Bouvier, male (AM P. 19584), cw. 146 mm: a, left first pleopod, abdominal aspect; b, left first pleopod, tip, abdominal aspect; c, left first pleopod, tip, sternal aspect.



A

B

Fig. 10. *Cancer trispinosus* Herbst, male (Holotype, "Ostindien", Zoologisches Museum, Berlin): a, dorsal aspect; b, ventral aspect. (Photo — Miss V. Kopke, Zool. Mus. Berlin.)

THE INDIGENOUS EARTHWORMS (MEGASCOLECIDAE: OLIGOCHAETA) OF LORD HOWE ISLAND

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SUMMARY

The known indigenous earthworms of Lord Howe Island are restricted to the subfamily Megascolecinae. They are assignable to six genera with ten species, *Diporochaeta plutelloides* sp. n., *Plutellus hutchingsae* sp. n., *Paraplutellus insularis* Jamieson, and *Pericryptodrilus nanus* gen. et sp. n. (Tribe Perionychini), *Eastoniella* gen. n. with *E. howeana* and *E. modesta* spp. n. (Tribe Dichogastrini) and *Spenceriella* (*Austroscolex*) subgen. n., with *S.* (*A.*) *howeana*, *S.* (*A.*) *difficilis*, *S.* (*A.*) *hollowayi* and *S.* (*A.*) *saundersi* spp. n., (Tribe Megascolecini). In addition to these 10 endemic species, the circummundane *Amynthas diffringens* Baird and the anthropochorous holarctic family Lumbricidae are recorded from the island. *Diporochaeta* and *Spenceriella* (*Austroscolex*) are otherwise restricted to Australia and (secondarily?) New Zealand, and *Plutellus* to Australia. *Pericryptodrilus* and *Eastoniella* are known only from the island but have strong Australian affinities. The earthworm fauna thus appears to be of Australian origin. Evidence for rifting of the Lord Howe Rise from Eastern Australia at ~80 million years before the present is noted but it is considered unlikely that the earthworm fauna dates from that period in view of catastrophic vulcanism on the island between ~30 and 8 million years before the present. The zoogeography and evolution of the earthworms is discussed and a tentative hypothesis of origin of the predominantly Oriental genus *Pheretima* s. lat. from an Australian precursor of *Spenceriella* is advanced.

INTRODUCTION

Lord Howe Island, 700 km NE of Sydney, Australia, at lt. 31°31'S, long. 158°04'E, is one of several volcanic peaks on Lord Howe Rise, the others, with the exception of Ball's Pyramid 20 km away, being submerged. The Rise which joins the Coral Sea Platform in the north and the Campbell Plateau in the south on which New Zealand is situated, forms an easterly and northeasterly boundary of the Tasman Sea. The bed of the Tasman Sea is bisected by an extinct tectonic ridge (mid-ocean ridge), trending approximately north-west to south-east, the morphology of which is consistent with its having been the axis of origin of sea-floor spreading. Hayes and Ringis (1973) have brought the two oldest corresponding magnetic anomalies together (80 million years before the present), the one closest to the continental edge of east Australia, the other closest to the Lord Howe Rise, and state that because of the well developed magnetic pattern there is "not much uncertainty" as to the pre-rifted configuration of the two continental elements. Their reconstruction, bringing the Lord Howe Rise into contact with eastern Australia at 80 million years before the present, is of the greatest interest for zoogeography as it establishes that the primary faunistic affinities of the Lord Howe Island area must have lain with eastern Australia, of which it was a part. At that

Records of The Australian Museum, 1977, **30**, 272-308, Figures 1-7.

time New Zealand, with which the island shows considerable biogeographic affinities, was, according to the reconstruction, very much closer to Australia (and Antarctica which this abutted) than at present. Nevertheless New Zealand seems to have had no direct land connection with Australia and the pre-rifted Lord Howe Island area.

To suggest that the Lord Howe Rise, and the island itself, originated by rifting from Australia in the Cretaceous and probably possessed an Australian flora and fauna is not, however, to suggest that Australian elements in the present fauna of the island necessarily represent a survival of that fauna. Even if the island has had a continuous history as an exposed land mass, above sea level, it is questionable that its fauna could have survived the formation of the oldest volcanics 30 m.y.B.P. or the catastrophic and very extensive late Miocene volcanics at about 8 m.y.B.P. (Standard, 1961; Game, 1969) which latter produced Mts Gower and Lidgbird and peripheral areas, since lost by erosion, of a much larger island. It is not unlikely that the contemporary fauna of the island is of post-Miocene origin and that the Australian elements of its terrestrial invertebrate fauna were therefore acquired from Australia when the island was only about one tenth nearer Australia than it is at present.

It is the aim of the present paper to describe the indigenous earthworm fauna of the island and to attempt to establish the taxonomic and zoogeographic affinities of this fauna.

Explanations of descriptive terminology are given in Michaelsen (1900), Stephenson (1930) and Jamieson (1974). In the lists of material examined "W" refers to the registration number of specimens in the Australian Museum, and "BJ" indicates that specimens are lodged in the author's collections. Unless otherwise stated, collections were made by Dr. P. Hutchings from 15-21 April 1971. Italicised numerals denote the collecting sites (see map, Fig. 1). Abbreviations for specimens are H (holotype) and P (paratype). Abbreviations used in illustrations are indicated under Fig. 2.

SYSTEMATICS

Eleven species assignable to the indigenous family Megascolecidae are present in the Lord Howe Island collections. They are described in alphabetical order under their genera which, in turn, are grouped according to the tribes to which they belong. Some members of the holarctic earthworm family Lumbricidae are also present but are beyond the scope of this work. A key to the eleven Megascolecidae follows. For correct identification, in view of the possibility of new species coming to light, agreement with illustrations and text should be checked.

KEY TO THE MEGASCOLECID OLIGOCHAETES OF LORD HOWE ISLAND

1. Setae 8 per segment 2
— Setae more than 8 per segment 6

2. (1) Nephridia 2 per segment 3
— Nephridia more than 2 per segment 5

3. (2) Nephropores on each side with definite alternation
Nephridial bladders present 4
— Nephropores on each side in a straight series
Nephridial bladders absent .... *Diporochaeta plutelloides*, Fig. 2A, p. 274

4. (3) Calciferous glands 1 sessile pair in segment XIII
Gizzard absent .... *Paraplutellus insularis*, Fig. 2C, p. 277
— Calciferous glands 4 long-stalked pairs, in segments X-XIII
Gizzard present in segment V .... *Plutellus hutchingsae*, Fig. 2B, p. 276

5\. (2) Gizzard in segment VIII .... *Eastoniella howeana*, Fig. 3B p. 281
Gizzard in segment IX .... *Eastoniella modesta*, Fig. 3C, D, p. 282

6\. (1) Nephropores externally visible as 3 straight rows on each side, in line with the second, tenth and penultimate dorsal seta; the intermediate row more strongly developed than the others ....*Pericryptodrilus nanus*, Fig. 3A, p. 279
— Nephropores very numerous but not externally recognizable 7

7\. (6) Spermathecal pores 2 pairs, in 7/8 and 8/9. Gizzard rudimentary, in V. Intestinal caeca absent. Testis-sacs absent 8
— Spermathecal pores 4 pairs, in 5/6-8/9. Gizzard large, in segment VIII. Intestinal caeca in segment XXVII. Testis-sacs present. (Holandric) .... *Amynthas diffringens*, p. 292

8\. (7) In segment XII, setae more than 40; interval between dorsal setae (zz) less than 10% of body circumference. Interval between last spermathecal pores 0.1-0.2 of circumference 9
— In segment XII, setae less than 30; interval between dorsal setae 10-26% of circumference. Interval between last spermathecal pores ~0.2-0.4 of circumference... 10

9\. (8) In segment XII, setae more than 50; interval between ventral setae (*aa*) 3-4% of circumference. Accessory genital markings, when present, including paired post-spermathecal discs lateral of setal lines 6......... .... *Spenceriella* (*Austroscolex*) *saundersi*, Fig. 5A, B, p. 290

— In segment XII, setae less than 45; interval between ventral setae (*aa*) 6% of circumference. Accessory genital markings including paired post spermathecal pads with porelike centres in setal lines 2-3............. .... *Spenceriella* (*Austroscolex*) *hollowayi*, Fig. 4B, C, p. 287

10\. (8) In segment XII, setae 20 or less; interval between ventral setae (*aa*) 6-10% of circumference. Accessory genital markings, when present, including paired post-spermathecal discs in setal lines 2-5 .... *Spenceriella* (*Austroscolex*) *howeana*, Fig. 4A, p. 288
— In segment XII, setae more than 20; interval between ventral setae (*aa*) 12-13% of circumference. Accessory genital markings unknown. .... *Spenceriella* (*Austroscolex*) *difficilis*, p. 286

Subfamily MEGASCOLECINAE Michaelsen, 1900 *sensu* Jamieson, 1971a
TRIBE PERIONYCHINI Jamieson, 1971a
Genus **Diporochaeta** Beddard, 1890, *sensu* Jamieson, 1975
Diporochaeta plutelloides sp. n.
Fig. 1, 2A, 6C, 7A. Table 1.

1 = 110 mm; w (mid-clitellar) = 3.2 mm; s = 188. Form dorso-ventrally depressed; clitellum lighter brown. Prostomium epilobous 1/2, open. Canalicula absent. First dorsal pore 4/5. Setae 8 per segment, commencing in II, in longitudinal rows all of which become slightly irregular posteriorly; setae *a* absent, *b* to *d* present, in XVIII.

Nephropores inconspicuous in *c* lines. Clitellum annular, weakly developed in XIII-XVII; dorsal pores and intersegmental furrows fainter than elsewhere; setae clearly visible. Male pores on XVIII, 0.88 mm, 0.11 body circumference, apart; each a transversely extensive slit centred in *a*, each pore surrounded by a transversely elliptical glandular genital marking

(porophore) which forms a depression but has a raised lateral margin, the two markings filling XVIII longitudinally and extending transversely from *b* lines to the ventral midline, where they merge; a small midventral elliptical accessory genital marking in 17/18 filling the space between the porophores and the anterior margin of XVIII; this accessory marking traversed by the intersegmental furrow. Female pores inconspicuous, one third of the distance between the setal arc and the anterior border of XIV in *a* lines. Spermathecal pores 3 pairs of small eyelike orifices, near but not at the posterior borders of VI, VII and VIII, their median borders in *a* lines; last pores 0.92 mm, 0.13 body circumference, apart.

No septa strongly thickened but 7/8, 8/9 and 9/10 moderately thickened. Dorsal blood vessel single, but bifurcating in III under the brain. Supra-oesophageal in IX-XIV, adherent to the roof of the oesophagus, from the vascular plexus of which it here receives vessels, but almost as wide as the dorsal blood vessel. Last hearts in XIII; those in X-XIII larger than the other commissurals and receiving each a wide connective from the dorsal and the supra-oesophageal vessel (latero-oesophageal hearts); commissurals in VI-IX still considerable but dorsoventral only and decreasing in size anteriorly. Gizzard absent; pharyngeal glands forming a unified large mass concealing the gut as far posteriorly as VI; oesophagus moniliform and widened, with circumferential blood vessels forming a plexus, in IX-XIV and less so in the anterior half of XV; poorly vascularized and narrow in the posterior half of XV. The vascularized region with low internal blood filled rounded villi but calciferous glands absent. Intestinal origin XVI; muscular thickening, caeca and typhlosole absent. Holonephric with transition to meronephry; nephridia not demonstrable in II; small in III; increasing in size and number of separate tubules and forming sessile tufts to X; small and less complex in XI and XII; but again large and complex in XIII-XVII and only slightly smaller, but still forming tufts far into the intestinal region; a very large preseptal funnel demonstrated on each side from segment IX to the caudal extremity but possibly present more anteriorly; ducts only sporadically traceable; some in the caudal segments demonstrated entering the parietes in *c* lines; the tufts in V appearing to send a (composite?) duct to the pharynx; bladders absent. Tufting in oesophageal and clitellar segments appears to have advanced to meronephry though the single preseptal funnel on each side of the gut is well developed. Holandric; compacted sperm masses and very large complexly convoluted iridescent sperm funnels in X and XI; testis-sacs absent; large compact racemose seminal vesicles in IX and XII. Prostates tubuloracemose, a pair of wide tubes in XVIII-XXII cross section elliptical, slightly variable in width; the exterior frequently though not deeply incised and not significantly lobulated; hooked entally and convoluted in XVIII but otherwise straight; the sinuous muscular duct in XVIII widening ectally and ensheathed in a thin layer of peritoneal connective tissue; vas deferens joining the gland shortly before this joins its duct. The prostates supplied by a large pair of parietal trunks passing posteriorly from beneath the oesophagus in XIII. Penial setae absent. Metagynous; ovaries very large palmate structures with many strings of large oocytes, and large pleated funnels in XIII; ovisacs absent. Spermathecae 3 pairs, in VII, VIII and IX, each with an ovoid ampulla and a short narrow duct which is joined medially, shortly ental of midlength, by a subspherical to stoutly clavate inseminated diverticulum; size uniform; length of right spermatheca of IX 1.1 mm; ratio of length spermatheca: length duct = 3.4; ratio of length: length diverticulum = 3.7.

MATERIAL EXAMINED: 6, 31°35′03½″S. 159°04′56″E. Mt. Gower ridge, close to stream; leaf litter in places, elsewhere dense moss covering trees; — Holotype (W6566).

REMARKS: The male genital field (with its combination of large, low almost contiguous porophores and median accessory marking at 17/18), the absence of a gizzard and the unusually extensive tufting of nephridia distinguish *D. plutelloides* from all other species of this genus.

Genus **Plutellus** Perrier, 1873
Plutellus hutchingsae sp. n.
Fig. 1, 2B, 6H, 7E-I. Table 1

1 = 36 mm (H), 50 mm (Pl), w (midclitellar) = 2.3 mm, (post-clitellar = 3.1 mm), s = 127 (H), 137 (Pl). Form moderately stout, ventrally flattened in *bb*, lacking appreciable secondary annulation. Pigmentless buff in alcohol. Prostomium broad, epilobus, 1/2 (H, P2) to 5/6 (Pl), laterally demarcated by deep grooves, posteriorly by a faint groove (H) or open (P1, 2). First dorsal pore 4/5 (H, P1-3). Setae in 8 regular longitudinal rows, commencing on II; *ab* absent, *bc* present, in XVIII.

Nephropores conspicuous to poorly visible; anterior in their segments in more than one series on each side in the holotype in *d* lines in II; in *c* lines in III-V; in *d* in VI; in *b* in VII and thereafter alternating regularly from *d* to *b*. Paratype 1 shows precisely the same arrangement on the left side but on the right side alternation from *b* to *d* starts in V.

Clitellum developed in holotype only, annular, strongly tumid but narrow relative to adjacent segments, embracing XIV-XVII; dorsal pores and intersegmental furrows totally obliterated; setae and intersegmental furrows fainter than elsewhere. Male genital field; male pores equatorial on XVIII in *ab* slightly (H) or very much (P1-3) nearer *a* than *b*, minute points in oval depressed dark glandular areas each of which extends from approximately *a* to shortly lateral of mid *ab*; the pores 1.02, 0.58, 1.16 mm, 0.12, 0.08, 0.10 body circumference, apart (H, P1, P5). Accessory genital markings depressed oval glandular areas with porelike centres presetal, or extending slightly postsetally, a pair in each of XX and XXI with centre slightly median of mid *ab*; a pair of presetal glandular markings median to *a* lines and almost contiguous in the midline, in XIX; a pair of low oval prominences almost filling XI longitudinally, reaching *b* laterally and extending slightly median of *a* (H). The accessory genital markings of the paratype conform with those of the holotype with the exception that paratype 1 has a pair of markings in XII, in addition to those in XI, and in XIX apparently has a median unpaired rather than paired marking; and paratype 2 has an additional presetal marking in *ab* unilaterally, on the left, in XXII. Female pores a pair in XIV, midway between the setal arc and the anterior margin and very slightly median of, almost in, *a* lines (H, P1-3). Spermathecal pores inconscipuous, 5 pairs at the anterior margins of V-IX, in *a* lines; the last pair 0.66, 0.46, 1.12 mm, 0.10, 0.08, 0.10 body circumference apart (H, P1, P5).

Internal anatomy (Holotype; gross anatomy confirmed from paratype 1): Septa 5/6 and 6/7 slightly thickened; 7/8 and 8/9 moderately thickened; 9/10-12/13 strongly; 13/14 moderately; 14/15 very slightly thickened, the remainder thin. Last septal glands in IV. Dorsal blood vessel single; continuous onto the pharynx, closely adherent to the intestine; free on the oesophagus. Dorsoventral commissural vessels in VI-XIII, all valvular; those in X-XIII forming 4 pairs of moderately large latero-oesophageal hearts, each of which arises from and lies behind the corresponding calciferous vessel and also receives a connective from the dorsal blood vessel. The two large calciferous vessels of a segment branch at the oesophageal end of the long duct of the calciferous gland to give about 10 vessels running longitudinally in the wall of the duct and further dividing in the lamellae of the gland. Medianly the two calciferous veins are continuous across the roof of the oesophagus and a midventral supraoesophageal vessel joins the points of fusion, in XI-XIII. A pair of suboesophageal vessels provides a branch on each side to the corresponding calciferous gland; the suboesophageal vessels are traceable at least as far forward as segment V and in XIV diverge laterally to form a pair of longitudinal lateroparietal vessels which enter XVIII but are not visible further posteriorly. Subneural vessel absent.

Oesophagus thin-walled in IV; in V forming a short cylindrical, firmly muscular gizzard; thin-walled whitish and intersegmentally constricted in VI-XIV but in each of X-XIII bearing a pair of long-stalked, reniform calciferous glands, the stalks of which join the oesophagus

laterally. Intestine commencing, with abrupt expansion, at the anterior septum of XV; muscular thickening, caeca and typhlosole absent. Nephridia stomate, vesiculate exonephric holonephridia throughout, commencing in II. Each bladder anteriorly, e.g. in VI, a narrow and elongate expansion of the ectal nephridial duct; in the anterior intestinal region expanded over the pore but attenuated to one side where the ectal nephridial duct enters; in the caudal segments similar but less drawn out at the entrance of the duct; diverticula absent although the side of the bladder opposite the duct (intestinally and caudally) is suggestive of a rudimentary diverticulum.

(Testes?), and firm flocculent sperm masses attached to iridescent sperm funnels in X and XI; racemose seminal vesicles in IX and XII, the posterior pair the larger but only moderate-sized; vasa deferentia on each side double but in a common sheath, wide and conspicuously visible winding posteriorly, free in the coelom on the ventral body wall; the prostate duct having the appearance of an ectal expansion of the vasa deferentia, i.e. an atrium; the thickly tubular prostate gland, which is restricted to XVIII, joining the atrium by a slender, short duct. Penial setae absent. Ovaries, a few separate chains of oocytes, (H) and funnels in XIII; ovisacs absent (H, P1).

Spermathecae 5 pairs, discharging anteriorly in their segments, each with an ovoid ampulla and a long duct consisting of a wide portion ental to the elongate clavate diverticulum and a very short, narrow portion ectal to the diverticulum (H, P1). Size uniform; length of the right spermatheca of IX (H) = 0.65 mm; ratio of total length: length diverticulum = 1.6.

MATERIAL EXAMINED: *17*, 31°34′52″S. 159°05′07″E. At the foot of the cliff at Mt. Gower. *Dracophyllum fitzgeraldii* — in leaf litter; — Holotype (W6567), *8*, 31°35′05″S, 159°4′52″E. Mt. Gower ridge, in thick moss covering the ground; — paratype 6 (W6568); *20*, 31°34′34″S, 159°05′03″E. Stream crossing in Erskine Valley; grass, *Howea belmoreana, Cleistocalyx fullageri, Pandanus forsteri, Drypetes australasica*; — P1-P3 (W6569), P4 (BJ), 2 (W6570). Camp site, Mt. Gower; — P5 (BJ); Lord Howe Island (no further data); collector Saunders — 3 (W1509).

REMARKS: *Plutellus hutchingsae* has very close affinities with the two other species of *Plutellus* s. strict. Jamieson, 1971b, viz. *P. heteroporus* Perrier (which is presumably Australian although stated by Perrier to be Pennsylvanian) and *P. manifestus* (Fletcher), from New South Wales. The restricted genus therefore remains very homogeneous. The three species nevertheless show clear specific differences. Some features which distinguish *P. hutchingsae* from the other two species are the disposition of the accessory genital markings; location of the spermathecal pores in *a* lines; and occurrence of the last hearts in segment XIII.

Genus **Paraplutellus** Jamieson, 1972a

Paraplutellus insularis Jamieson, 1972a

Paraplutellus insularis Jamieson, 1972a: 85-86, Fig. 1A-C, Table 4

TAXONOMIC NOTE: This species was previously known only from two specimens. The present series of forty-five identifiable specimens shows the species to be the commonest and most widely distributed earthworm in natural habitats on Lord Howe Island. Great variation in size is exhibited and the distribution of markings is variable but there is no evident correlation between the arrangement of markings and size-classes. There thus seems no reason to doubt that all specimens in the series are conspecific. The distribution of genital markings in the holotype remains the most extensive known for the species though an extra pair of markings, in intersegment 19/20 in *ab*, not seen in the types, occurs in three specimens. The distribution of genital markings in eighteen clitellate specimens compared

with the distribution in the holotype follows. The number of specimens, of these eighteen, with a given location of genital markings is given in parentheses following the location recorded for the holotype. All markings are paired, though occasionally only developed unilaterally. In VI, lateral of *b* (none); VII, lateral of *b* (4; in *c* to *d*); VIII (3; in *bc* to *d*); IX, presetal in *ab* (none); X and XI, presetal in *ab* (2); anterior margin of XVIII (17); anterior margin of XIX (18); intersegment 19/20, in *ab* (3; these markings absent from the types). Thus the most characteristic markings are those anteriorly in XIX which appear to be invariably present in sexual specimens. Those in XVIII, in front of the male porophores, though usually present, are often very indistinct.

MATERIAL EXAMINED: *2*, 31°30′56″S, 159°02′55″E. Dense mixed forest; *Howea forsterana* dominant; leaf litter 1″-1½″ thick, sandy dark soil; — 3 (W6571); *5*, 31°34′26″S, 159°04′39″E. Erskine Valley. *Pandanus forsteri, Drypetes australasica, Howea* sp., *Cleistocalyx fullageri, Linociera quadristaminae*. Moist dark soil under deep leaf litter — 1 (W6572); *6*, 31°35′03½″S, 159°04′56″E. Mt. Gower ridge, close to stream; leaf litter in places, elsewhere dense moss covering trees; — 4 (6573); *7*, 31°35′04″S, 159°04′55″E. Mt. Gower ridge, in a layer of soil beneath moss on a tree trunk; — 1 (W6574); *8*, 31°35′05″S, 159°04′52″E. Mt. Gower ridge, in thick moss covering the ground; — 1 (6575); *9*, 31°35′06″S, 159°04′49″E. Mt. Gower ridge, under dense vegetation in ground with sparse leaf litter; — 1 (W6576); *10*, 31°35′07″S, 159°04′48″E. Mt. Gower ridge, in leaf litter; — 4 (W6577); *12*, 31°35′09″S, 159°04′46″E. Mt. Gower ridge, in dense moss on the ground and in fallen logs; — 3 (BJ); *13*, 31°35′01″S, 159°04′49″E. At the foot of small stream running at right angles to Mt. Gower ridge, in the moss on the stones near the stream; other vegetation *Dracophyllum fitzgeraldii; Passiflora edulis;* tree ferns; — 5 (W6578); *15*, 31°35′03″S, 159°04′53″E. Up stream running at right angles to Mt. Gower ridge, very dense vegetation, in aerial roots and in the base of fronds of the palm, *Hedyscepe canterburyana;* — 2 (6579); *15*, 31°35′03″S, 159°04′53″E. Up stream running at right angles to Mt. Gower ridge, very dense vegetation, in aerial roots; — 1 (W6580); *19*, 31°34′37″S, 159°05′06″E. Going down into Erskine Valley from Mt. Gower; *Pandanus forsteri, Dracophyllum fitzgeraldii*, mountain palms. *Coprosma putida*, in soil under leaf litter; — 2 (W6581); *28*, 31°31′51″S, 159°04′40″E. Up towards Transit Hill. Woodland on coral sand; *Drypetes australasica, Cryptocarya triplinervis, Ficus columnaris, Howea forsterana, H. belmoreana;* — 1 (W6582); *30*, 31°31′55″S, 159°04′52″E. Woodland lacking coral sand, *Drypetes australasica, Cryptocarya triplinervis, Ficus columnaris, Howea forsterana, H. belmoreana, Cleistocalyx fullageri, Linociera quadristaminea*, in leaf litter and soil; — 3 (W6583); *30*, 31°31′55″S, 159°04′52″E. Woodland lacking coral sand, *Drypetes australasica, Cryptocarya triplinervis, Ficus columnaris, Howea forsterana, H. belmoreana, Cleistocalyx fullageri, Linociera quadristaminea*, in the base of palms, worms less abundant in this habitat than on Mt. Gower; — 3 (BJ); *35*, 31°32′54″S, 159°05′44″E. Going up North Hummock, few palms, *Howea forsterana* and *H. belmoreana, Xylosma ovatum, Elaeodendron curtipendulum;* — 1 (W6584); *38*, 31°33′27″S, 159°05′23″E. Up Smoking Tree Ridge. Open woodland with *Howea forsterana;* in leaf litter and in soil; — 4 (W6585); *39*, 31°33′50″S, 159°05′39″E. At the top of Goat House, just around the ledge, *Dracophyllum fitzgeraldii, Cassinia tenuifolia* Tree-fern, *Pimelea congesta, Olearia ballii, Metrosideros nervulosa;* from pockets of soil or leaf litter between large boulders; a thin covering of moss on ground; — 4 (W6586); (no data). 8-9, 1966 — 10 (W6587); Lord Howe Island (no further data) — 4 (W4567).

Pericryptodrilus n. gen.

DIAGNOSIS: (Perichaetine). Combined male and prostatic pores a pair on XVIII. Spermathecal pores pretesticular (and intersegmental). Gizzard (rudimentary) in V. Calciferous glands absent. Intestine lacking typhlosole, muscular thickening and caeca absent. Meronephric; pharyngeal or other enteronephric nephridia and tufted nephridia

absent; nephridia each with a bladder, in 3 longitudinal rows on each side; those of the intermediate series with preseptal funnels. (Holandric; metagynous). Prostates tubular. (Spermathecae diverticulate).

DISTRIBUTION: Lord Howe Island.

TYPE-SPECIES: *Pericryptodrilus nanus* sp. n. (Monotypic genus).

REMARKS: *Pericryptodrilus* agrees with *Cryptodrilus* Fletcher (1887) in having meronephridia with bladders, a condition unrecorded in other genera of the Megascolecidae in Australia but described by Gates (1943) for *Pleionogaster* Michaelsen (1892), a genus from the Philippines and Moluccas. It differs from *Cryptodrilus* in being perichaetine, a condition now known to be of little significance, and notably in that whereas in *Cryptodrilus* the medianmost nephridium, only, may have a preseptal funnel, it is the intermediate nephridium which is stomate in *Pericryptodrilus*.

Pericryptodrilus nanus n. sp.
Fig. 1, 3A, 6A, 7J, K. Table 2

l = 25 mm (P2) — 32 mm (H) (P1, posterior amputee); w (mid-clitellar) = 1.0 (P2), 1.2, (H), 1.5 mm (P1); s = 111 (H) — 123 (P2). Form slightly depressed dorsoventrally; secondary annulation absent but setae on circumferential annuli. Prostomium broadly epilobous >1/3 < 1/2. First dorsal pore 6/7 (H, P2) or 10/11 (P1). Setae commencing on II; numbers per segment 34, 30 on XII; 34, 31 on XX; 43, 32 fifteen segments from the posterior end (H, P2 respectively) *aa* a clearly recognizable interruption in the setal circle; setae *a* and *b* absent in XVIII; no setae notably enlarged.

Nephropores 3 straight series on each side, in line with the penultimate setae (*y*), in approximately the tenth setal row and in line with the second setae (*b*), at the anterior margins of their segments, the dorsal and ventral series discernible only with difficulty and not certainly continuous to the anterior end; the intermediate series (in s.1.10) conspicuous from intersegmental furrow 1/2 posteriorly. Clitellum annular, slightly protuberant, embracing 1/2 XIII (P1, 2), XIV (H) — XVI (H, P1, 2); nephropores and setae retained; dorsal pores and intersegmental furrows obscured. Small slit-like combined male and prostatic pores a pair in XVIII approximately in *b* on prominent papillae which when well developed (Holotype) occupy about one third of the length of the segment, their lateral borders indistinct, in *bc*; a midventral depression present in the holotype, but not in the paratypes, between them; the pores 0.30, 0.58 mm, 0.08, 0.16 body circumference apart (H, P2). Accessory genital markings 2 midventral presetal circular glandular areas, with indistinct porelike centres, one in XX, the other in XXI (H). Female pore unpaired, midventral on XIV, midway between the setal arc and 13/14, surrounded by an oval glandular area; spermathecal pores 2 pairs, in 7/8 and 8/9, between the third and fourth setal rows (H, P1, 2). The last spermathecal pores 0.66, 0.72 mm, 0.24 body circumference apart (H, P2).

Septa: 5/6 — 7/8 slightly thickened; 8/9 — 10/11 moderately thickened (9/10 the strongest); the remainder thin (schizoparatype). Dorsal blood vessel single, continuous onto the pharynx. Latero-oesophageal hearts 3 pairs, in X-XII; no dorsoventral commissural vessels recognizable in IX anteriorly (H, P2). Supra-oesophageal vessel in VIII (P2), IX (H) — XII, weakly developed. Oesophagus not enlarged, but moniliform and of uniform width in IV-VII, the wall in V seen in the schizoparatype to possess considerable muscular thickening and warranting recognition of a rudimentary gizzard. Oesophagus narrow and tubular in VIII; intersegmentally constricted and somewhat vascularized in IX-XIV; strongly dilated in XIII (H) or XIII and XIV (P2), internally rugose; calciferous glands at least extramurally absent; oesophageal walls with well developed sinus in IX posteriorly; this wide sinus continuous in the intestinal walls to XVII; a narrower sinus present posteriorly

(schizoparatype); oesophagus narrower in XV; intestine commencing with abrupt expansion in XVI (H, P2), origin not certainly determinable in the schizoparatype; typhlosole, muscular thickening and caeca absent.

Nephridia: 3 subspherical slightly bilobed nephridial bladders present on each side per segment, those in the tenth setal lines, large and conspicuous; the upper in *y* lines small; those in *b* lines still smaller. The nephridia of the intermediate series each with a preseptal funnel near the nerve cord; no funnels demonstrable for the dorsal and ventral series, the nephridial tubules of which are short and discernible only with difficulty. Pharyngeal, or other enteronephric nephridia, and tufted nephridia absent (H, P2). Location of bladders confirmed in transverse sections of posterior half of P3.

Testes, large firm sperm masses and iridescent sperm funnels in X and XI; racemose seminal vesicles in IX and XII, the posterior the larger. Only the anterior sperm funnels iridescent in P2 and only the posterior funnels sperm-carrying in the schizoparatype. Small tongue-like ovaries, lacking evident oocytes and moderate-sized funnels in XIII (H, P2). Large multiloculate ovisacs in XIV (H, P2). Prostates thickly tubular, in XVIII and extending into XIX; ducts median, slender (H, P2); vas deferens joining each gland at its junction with the duct (H). Penial setae absent. Spermathecae discharging anteriorly in VIII and IX; each with a subspherical ampulla, conical, entally almost equally wide and a large clavate inseminated lateral diverticulum which joins the duct at midlength; the diverticulum (H) with or without a subsidiary less well developed or knoblike diverticulum of similar width at its base or (P2) all simple; size approximately uniform; length of left spermatheca of IX (H) = 0.40 mm; ratio total length spermatheca: length duct = 1.6; ratio total length: length diverticulum = 1.2.

MATERIAL EXAMINED: *6*, 31°35′03½″S, 159°04′56″E. Mt. Gower ridge, close to stream; leaf litter in places, elsewhere dense moss covering trees; under leaf litter; — Holotype (W6588); *15*, 31°35′03″S, 159°04′53″E. Up stream running at right angles to Mt. Gower ridge, very dense vegetation, in leaf litter; — Paratypes 4, 5 (W6589). Summit of Mt. Gower; collector J. Dysney, 1 Aug. 1971 — P1 (BJ), P2, 3 (W4561), 2 (6590 ex W4561); (no data), 8-9, 1966 — P6 (BJ).

REMARKS: *Pericryptodrilus nanus* is exceptionally small for a megascolecid oligochaete. The median accessory genital markings and three rows of nephropores readily distinguish it from the other oligochaetes of the island.

Eastoniella n. gen.

DIAGNOSIS: Setae 8 per segment. Combined male and prostatic pores a pair on XVIII. Spermathecal pores pretesticular and intersegmental. Gizzard in VIII or IX. Calciferous glands absent. Intestine simple. Meronephric; pharyngeal nephridia or tufts absent; oesophageal and anterior intestinal nephridia astomate; caudally the median ventral nephridium on each side with a preseptal funnel which is at first multilipped but further posteriorly is simple; the nephridia with simple funnels enlarged as megameronephridia; enteronephry absent (?). (Holandric; metagynous). Prostates tubular.

DESCRIPTION: Terrestrial. Body circular in cross section. Prostomium epilobous (to tanylobous?). Dorsal pores absent. Setae 8 per segment, commencing on II; widely paired; *cd* very slightly smaller than *bc*; *dd* 0.3-0.4 circumference. A pair of combined male and prostatic pores on XVIII. Clitellum annular (extending behind the male pores?). Intersegmental unpaired accessory genital markings present. Female pores inconspicuous, paired, anteromedian of setae *a* of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9.

Some oesophageal septa strongly thickened; none aborted. Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XIII; those in X, XI-XIII latero-oesophageal, with

connectives from the dorsal vessel and the oesophageal plexus; supra-oesophageal vessel weakly developed or unrecognizable; subneural vessel absent. Gizzard vestigial or strongly developed in VIII or IX; extramural calciferous glands absent. Intestinal origin XVI; typhlosole, caeca and muscular thickening absent. Meronephric; anteriorly with numerous astomate, exonephric, parietal micromeronephridia on each side. Pharyngeal or anterior tufted nephridia absent. Caudally with astomate micromeronephridia and a median ventral meronephridium, on each side, with preseptal funnel which is at first multilipped, but further posteriorly is simple; those nephridia with simple funnels are enlarged as megameronephridia; enteronephry absent? Testes and funnels in X and XI; testis-sacs absent; seminal vesicles in IX and XII (or XI only?). Ovaries and funnels in XIII; ovisacs (always?) absent. Prostates tubular though minutely lobulated. Penial setae absent. Spermathecae 2 pairs, each with a simple diverticulum.

DISTRIBUTION: Lord Howe Island.

TYPE-SPECIES: *Eastoniella howeana* n. sp.

OTHER SPECIES: *E. modesta* n. sp.

REMARKS: The presence in caudal segments of a stomate nephridium with preseptal funnel, median to astomate meronephridia places *Eastoniella* in the tribe Dichogastrini in which location of the gizzard in VIII or IX renders it unique. Elsewhere in the Megascolecidae the most posterior known location of the gizzard is VIII, in *Pheretima* and *Pleionogaster,* genera which show no close relationship to *Eastoniella*. The multilipped funnels of some of the stomate nephridia are a further peculiarity.

For a discussion of relationships of *Eastoniella* see p. 294

Eastoniella howeana n. sp.
Fig. 1, 3B, 6D, 7D, L. Table 1

1 = 80 mm, w (midclitellar) = 9 mm, s = 140. Form circular in cross section; first four segments simple; the remainder triannulate with, frequently, further subdivision of the annuli; triannulation especially clear in the forebody; postclitellar segments only about half as long. Prostomium epilobous, almost ½, almost square though slightly rounded anteriorly; demarcated posteriorly by a transverse furrow which continues on the peristomium on each side of it. Dorsal pores absent. Setae minute; not clearly discernible in the forebody; commencing on II, in 8 regular longitudinal rows throughout. Nephropores not externally visible. Clitellum imperfectly developed and damaged but appearing at the dorsal incision to occupy the posterior 1/3 XIII—anterior 2/3 XIX; intersegmental furrows and setae retained.

Male genital field: an exceedingly protuberant oblong ovoid tubercle with its length transverse to the body axis, filling XVII and XVIII longitudinally and including the anterior third of XIX; extending laterally almost to *b* lines, the tubercle traversed by a deep transverse furrow which divides it into an anterior larger portion, occupying the whole of XVII, and the anterior 1/3 of XVIII, though this portion appears to originate from the posterior and anterior annuli (thirds) of XVII and XVIII respectively and a posterior, smaller portion which appears to originate from the posterior two annuli (two thirds) of XVIII and the anterior annulus (third) of XIX. Male pores represented by inconspicuous mounds slightly lateral of *a* lines on the genital marking and in a position corresponding with the equatorial annulus of XVIII; the pores 2.8 mm, 0.13 body circumference, apart. Female pores a pair, very inconspicuous, shortly median to *a* lines, midway between the setal arc and the anterior margin of XIV. Spermathecal pores 2 pairs of inconspicuous orifices in 7/8 and 8/9 in *a* lines; the last pores 2.4 mm, 0.11 body circumference, apart.

Septa 4/5-7/8 strongly thickened; 8/9 very strongly thickened; 9/10 and 10/11 immensely thick; 11/12-13/14 moderately thick; the succeeding septa thin. Vascular system indeterminable (macerated and damaged). Oesophagus in VI-VII, and XI, elongate, vascular and tortuous, the anterior half in VIII forming a rudimentary but elongate and conspicuous gizzard; the vascularized region internally simple, noteworthy rugosity or recognizable calciferous development absent; intestinal origin indeterminable; typhlosole, muscular thickening and caeca absent.

Astomate, avesiculate exonephric integumentary micromeronephridia approximately 10-15 on each side in each segment commencing in II; approximately 75 segments from the caudal extremity the median or sometimes next lateral nephridium on each side has a preseptal composite nephrostome. The nephrostomes are largest anteriorly, where they are at least as large as a nephridium. Each has two rami; on the anterior face of each ramus, arranged in single file, are approximately 16 juxtaposed ciliated lobes each in the form of a simple nephridial funnel. Posteriorly on each ramus, there is a single such ciliated lobe on each side of the neck. At approximately 15 segments from the posterior end, the biramous funnels are replaced by simple funnels and the median nephridium is greatly enlarged to form a conspicuous megameronephridium. Pharyngeal nephridia absent and no intestinal or other enteronephry demonstrable.

Sperm funnels (and testes?) free in X and XI, only the funnels in X iridescent; seminal vesicles moderately large, recemose, in XI only, dependent from the anterior septum. Ovaries, a few attenuated strings of small oocytes, and funnels in XIII; oviducts paired. Ovisacs absent. Prostates tubular, minutely lobulated, with very narrow sinuous ducts entering a glandular mass which corresponds with the external genital marking, in XVIII; the glandular part extending anteriorly of the ducts for one to three segments, its free end attenuated as a slender tail; vas deferens joining the gland at its junction with the duct. Penial setae absent. Spermathecae 2 pairs opening anteriorly in VIII and IX; each with a broad sacciform ampulla and a wide, well demarcated, ectally tapering duct which receives the short duct of a subspherical diverticulum at its ectal third; size approximately uniform; length of right spermatheca of IX = 2.1 mm; ratio total length: length duct = 2.0; ratio total length: length diverticulum = 3.0.

MATERIAL EXAMINED: 6, 31°35'03½"S, 159°04'56"E. Mt. Gower ridge, close to stream; leaf litter in places, elsewhere dense moss covering trees; under leaf litter; — Holotype (W6591).

REMARKS: *Eastoniella howeana* is diagnosed within the genus by location of the gizzard in VIII and incipient proandry, with seminal vesicles in XI only. Its affinities are further discussed under *E. modesta*.

Eastoniella modesta n. sp.
Fig. 1, 3C-E, 6G. Table 1

Length = 100, 90 mm, w (midclitellar) = 5, 10 mm, s = 144, 119 (H, P). Circular in cross section. Pigmentless in alcohol. Prostomium tanylobous (?), extending to the posterior border of the first annulation (H); broadly epilobous (P). Canalicula and dorsal pores absent. Setae 8 per segment, in regular longitudinal rows excepting posteriorly where *d* line is very slightly irregular (H, P). Seta *a* (H) or *a* and *b* (P) absent in XVIII. Nephropores not externally recognizable. Clitellum not discernible (H) imperfectly developed with limits not certainly discernible but clitellar modification apparently embracing XIII-XXI (P). Male pores on XVIII, shortly lateral (and posterior?) to the sites of setae *a*; 2.2, 2.9 mm, 0.15, 0.10 body circumference, apart (H, P), each pore on a small, low, domed protuberance which is clearly delineated laterally (shortly median of *b*) but medially is continuous with a slight midventral tumescence (H) or transverse segmental papilla (P) which fills the posterior two thirds of

XVIII and impinges very slightly on XIX. A further transversely elliptical midventral pad present intersegmentally in 17/18, extending longitudinally from the setal arc of XVII to that of XVIII and laterally to *a* (P) or into *ab* (H); in H, segment XVII slightly tumid from the pad to intersegmental furrow 16/17. Female pores distinct minute pits shortly anteromedian of setae *a* of XIV (H, P). Spermathecal pores not externally visible; from internal examination 2 pairs, in 7/8 and 8/9, in *a* lines; the pores 1.8, 1.9 mm, 0.13, 0.09 body circumference apart (H, P).

Septa 9/10-12/13 very strongly thickened; 10/11 and 11/12 the thickest (H, P). Dorsal blood vessel single, continuous onto the pharynx (H, P). Supra-oesophageal present, as judged from union of supra-oesophageal connectives to the hearts, but not visibly differentiated (because of maceration?) as a vessel from the roof of the oesophagus (H) but visible in XIII, though weakly developed and not certainly continuous in XI and XII (P). Dorsoventral commissurals in VI-XIII (P); those in X (H), XI (P)-XIII (H, P) each receiving a slender connective from the dorsal vessel and from the middorsal line of the oesophagus (H) or from the distinguishable supra-oesophageal vessel (P); the hearts large in XIII, moderate-sized in XII and slender in X and XI (H) or all unusually slender (P); slender commissurals in IX anteriorly dorsoventral only; subneural not demonstrable (H, P). Gizzard barrel-shaped, very large, and strongly muscular (H) or thinner walled and slenderly fusiform (P) in IX; its location in this segment clearly indicated by the intervention of a section of narrow oesophagus which is short (H) or half the length of the segment (P) between its anterior limit and the thick septum 8/9 (the difference in size of the gizzard and length of preceding oesophagus presumably due to different contraction); septum 9/10 only slightly displaced posteriorly by the gizzard (H, P). Oesophagus in VI-VIII unusually long and capacious, so that it is contorted in each segment, its walls vascular but simple; shorter but similar in appearance in V (H, P); pharynx and buccal cavity in I-IV tubular, narrower than the oesophagus, and invested in III and anteriorly in a small glandular mass in which (apparently in III) the brain is embedded (H). Oesophagus behind the gizzard virtually supressed in X and XI but wide and vascular in XII-XIV in which it has numerous fine low internal circumferential ridges narrow in XV; morphologically differentiated calciferous glands absent; intestine commencing, with abrupt dilatation, in XVI; typhlosole, caeca and muscular thickening absent (H, P). Nephridia as for *G. howeana* but multilipped funnels smaller in H though similar in size in P. Holandric; large sperm funnels, with spermatozoal iridescence, in X and XI; testis-sacs absent; multiloculate seminal vesicles paired in IX and XII (H, P) that in XII extending through septum 12/13 into XIII (H). Metagynous (from disposition of pores in XIV); ovaries, oviducal funnels and ovisacs not demonstrable (H) or funnels only seen (P). Prostates a pair of narrow distinctly flattened straplike structures; almost straight, extending from XVIII to XXVIII, the surface minutely lobulated and occasionally slightly incised but with the appearance of tubular rather than racemose prostates; each with a short contorted, moderately muscular duct which is thinly ensheathed in parietal connective tissue (H, P); the ducts entering an internal glandular mass corresponding with the external genital marking in XVIII (P); slender vas deferens joining the duct shortly ental of the midlength of the latter (H). Penial setae absent (H, P). Spermathecae 2 pairs, in VIII and IX, each with an ovoid to spherical ampulla and an initially wide ectally tapering duct; an inseminated clavate diverticulum joining the duct medially where the duct reaches the preceding septum and commences to run ventrally in the septum; ectal half of the spermathecal duct concealed in this septum; length of right spermatheca of IX = 2.1, 2.2 mm, ratio total length of spermatheca: length duct = 2.8, 2.9; ratio length spermatheca: length diverticulum = 3.2, 3.1 (H, P).

MATERIAL EXAMINED: Lord Howe Island (no further data) — Holotype (W6592 ex W4567); lowlands — paratype, (W4564).

REMARKS: Location of the gizzard in segment IX in *Eastoniella modesta* appears to be the sole case in the Megascolecidae. Its occurrence in two of the three known specimens of

Eastoniella suggests that it is not an abnormality. This location of the gizzard, the holandric condition, with seminal vesicles in IX and XII, and maximal thickening of septa 10/11 and 11/12 rather than 9/10 and 10/11, all distinguish it from *E. howeana*. Otherwise the general morphology, including the genital field, is very similar in the two species and it is possible that discovery of larger series of specimens will necessitate regarding *E. modesta* as a junior synonym of *E. howeana*. Such variation in location of the gizzard infraspecifically is unknown elsewhere, however, except as an abnormality, and separation of the two entities as distinct species appears justified.

The setal ratios of the two species do not at present aid distinction of the two entities but similarity of the ratios is not greater than that between different species in other genera.

Tribe Megascolecini Jamieson, 1971a
Genus **Spenceriella** Michaelsen, 1907, emended definition

DIAGNOSIS: (Perichaetine). Combined male and prostatic pores a pair on XVIII. Spermathecal pores pretesticular (and intersegmental). (Accessory genital markings intrasegmental). Gizzard in V, (large or rudimentary). Calciferous glands 3 or 4 pairs dorsolateral in X, XI-XIII, or absent. Intestine lacking caeca. Meronephric; pharyngeal tufts present or absent; oesophageal nephridia astomate or stomate; caudal nephridia stomate (and astomate?); nephridia in regions in which they are stomate (always?) with multiple discrete intrasegmental, not preseptal, nephrostomal funnels per segment (excluding *S.* (*S*) *tasmanica* which has preseptal rudiments?) excepting the medianmost ventral nephridium which (always?, including *tasmanica*) has a preseptal funnel. Intestinal enteronephry present in at least some species. (Holandric; metagynous). Prostates racemose or tubuloracemose. (Spermathecae diverticulate).

DISTRIBUTION: Australia: Victoria, South Australia, New South Wales, Queensland, Tasmania; Lord Howe Island; Norfolk Island, New Zealand.

TYPE-SPECIES: *Diporochaeta notabilis* Spencer, 1900.

OTHER SPECIES: See Jamieson (1974b) and *S.* (*Austroscolex*), below.

Subgenus **Spenceriella** Michaelsen, 1907 *sensu* Jamieson, 1974b

DIAGNOSIS: Gizzard large. Three or four pairs of dorsolateral calciferous glands, in X, XI-XIII. Pharyngeal meronephric tufts present. Multiple intrasegmental nephrostomes (always?) present but caudal only (?).

Subgenus **Austroscolex** n. subgen.

DIAGNOSIS: Gizzard rudimentary. Extramural calciferous glands absent. Pharyngeal meronephric tufts absent; multiple intrasegmental nephrostomes in intestinal and (always?) oesophageal segments.

DESCRIPTION: Terrestrial. Body circular or depressed in cross section. Prostomium epilobous to tanylobous; peristomium sometimes bisected by a longitudinal furrow ventrally. First dorsal pore 4/5-6/7. Setae numerous in each segment, absent between the male pores. A pair of combined male and prostatic pores on XVIII. Clitellum annular, embracing 3 or more segments, always including XIV-XVI, maximally XIII-XVII; its dorsal pores and intersegmental furrows obscured at maturity but at least some setae visible. Segmental accessory genital markings present. Female pores inconspicuous, paired anteromedian of setae a or unpaired midventral, in XIV. Spermathecal pores 2 pairs, in intersegmental furrows 7/8 and 8/9.

Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XII, those in X posteriorly latero-oesophageal, each arising from the short (postgizzard) supra-oesophageal vessel and from the dorsal vessel. Subneural vessel absent. Gizzard rudimentary in V. Oesophagus with internal almost lamellar villi but lacking extramural calciferous glands. Intestine commencing in XVI; typhlosole, caeca and muscular thickening absent. Excretory system meronephric. Pharyngeal tufts absent; micromeronephridia numerous, in transverse parietal bands commencing in II; several to many nephrostomes present on each side in each segment in the intestinal region and (always?) the oesophageal regions, the funnel in the same segment as the body of the nephridium; caudally (always?) with, in addition, a preseptal funnel on the ventralmost median nephridium. Intestinal enteronephry present (?). Testes and funnels in X and XI; testis-sacs absent; seminal vesicles in IX and XII.

Ovaries and funnels in XIII; ovisacs usually present. Prostates racemose; (sometimes tubuloracemose?); vasa deferentia joining the glands near their muscular ducts. Spermathecae each with a clavate, uniloculate diverticulum.

DISTRIBUTION: Australia: Queensland; New South Wales; Lord Howe Island; Norfolk Island, New Zealand.

TYPE-SPECIES: *Austroscolex howeana* n. sp.

CHECKLIST OF SPECIES

1. *Austroscolex difficilis* n. sp. (Lord Howe Island)
2. *Austroscolex hollowayi* n. sp. (Lord Howe Island)
3. *Austroscolex howeanus* n. sp. (Lord Howe Island)
4. *Perichaeta newcombei* Beddard, 1887 (Queensland, New South Wales, New Zealand) (syn. *Megascolex laingii* Benham, 1903).
5. *Austroscolex saundersi* n. sp. (Lord Howe Island).

REMARKS: The genus *Spenceriella* Michaelsen, 1907a, has recently been redefined (Jamieson, 1974b) to include two new South Australian species; seven species from Victoria previously placed in other genera, in addition to the type-species; a Tasmanian species, and five species *incertae sedis* from Victoria and New Zealand. This entire group of species (with the possible exception of the species *incertae sedis*) now becomes the subgenus *Spenceriella* with no emendment of the description. The nephridial arrangement given in the diagnosis of *S. (Spenceriella)* above (caudal nephridia with postseptal nephrostomes but medianmost ventral nephridium with large preseptal funnel) is confirmed in the present study for paratypes of the South Australian species *S. imparicystis* and *S. penolaensis* but was not demonstrable in *S. (S). tasmanica* though this has stomate medianmost nephridia. (Jamieson, 1974a). In all three species intestinal enteronephry with longitudinal supraintestinal ducts has been demonstrated. The nephridia of the type-species are little known and those of the remaining species remain to be investigated. In the closely examined *S. (S). imparicystis* and *S. (S). penolaensis* nephrostomes are absent from the nephridia of the anterior intestinal and oesophageal regions, or at least are not demonstrable on diligent examination. Presence of anterior nephrostomes thus constitutes, as far as is known, a distinction of *S.* (*Austroscolex*) from *S.* (*Spenceriella*). This important distinction contains with additional distinctions — the reduced gizzard, absence of calciferous glands and of pharyngeal tufts — to clearly distinguish *S.* (*Austroscolex*) from *S.* (*Spenceriella*) and may later be considered to warrant separate generic status for *Austroscolex*. At present, however, *Austroscolex* seems satisfactorily accommodated as a subgenus in *Spenceriella*.

The enlarged genus is redefined, in a diagnosis, above. No one character is diagnostic but the possession of nephrostomes in the same segment as their meronephridial bodies is exceedingly rare in the Oligochaeta, being known in only the Megascolecidae and there in only *Spenceriella* and *Pheretima* s. lat. The affinities of *Spenceriella* with Australian and Oriental pheretimoids are further discussed on p. 294

Gemascolex, from South Australia and Victoria, shows close affinities with *Spenceriella* but is clearly distinguished by the preseptal location of the nephrostomal funnels, in addition to those of the medianmost ventral nephridia, in the segment in front of the corresponding nephridial bodies. The intersegmental location of accessory genital markings in *Gemascolex* further contrasts with their segmental location in *Spenceriella*.

Spenceriella (Austroscolex) difficilis n. sp.
Fig. 1. Table 2

1 = 152 (H), 224 (P) mm, w (midclitellar) = 4.5 mm, s = 84 + (H, posterior amputee), 120 (P). Circular in cross section. Pigmentless buff in alcohol. Prostomium tanylobous (H), or epilobous 1/3 (P), not canaliculate. First dorsal pore: 4/5 (imperforate, H) or 3/4 and 4/5 imperforate (P), 5/6 (perforate). Setae commencing on II; numbers per segment 26, 21 on XII; 32, 27 on XX; 40, 31, fifteen segments from posterior end (H, P respectively); *aa* and *zz* broad interruptions of the setal circlet in the forebody; recognizable but narrow posteriorly; setae *a* and *b* (and *c*?) absent in XVIII (H, P). Nephropores not visible. Clitellum annular, indistinctly developed, in 1/2 XIII-XVI. Male pores a minute pair in XVIII, not on papillae, between setal lines 2 and 3 relative to adjacent segments, 2.0, 2.8 mm, 0.17, 0.23 circumference, apart (H, P). Accessory genital markings not developed (incompletely mature?). Female pores minute, a pair at about 1/3 (H), 1/5 (P), the distance from the setal arc to the anterior margin of XIV, about 1/2 (H), 2/3 (P) *aa* apart. Spermathecal pores 2 pairs, in 7/8 and 8/9, in setal lines 3-4, short transverse slits on small but conspicuous papillae (P) or with level whitish margins (H); 2.8, 3.28 mm, 0.24, 0.31 circumference apart (H, P respectively).

Septa 7/8-13/14 strongly thickened, 12/13-13/14 the strongest. Gizzard rudimentary in V, concealed in the last septal glands. Intestinal origin 1/2 XVI. Nephridia lateral parietal bands of very numerous avesiculate stomate micromeronephridia, a transverse series of postseptal nephrostomal funnels demonstrable in the oesophageal and intestinal regions. Holandric; iridescent sperm funnels in X and XI; large racemose seminal vesicles of approximately equal size, and not transversely elongate, in IX and XII. Ovaries, large webs with many large oocytes, and funnels in XIII, large multiloculate ovisacs in XIV. Prostates each in the form of a flattened, lobulated S, the muscular external duct arising from the anterior 2 of the 3 portions and shown by dissection to give three or more branches immediately within the gland, being, therefore, racemose; vas deferens joining the anterior lobe of the gland near but not at the junction with the external duct. Penial setae absent. Spermathecae 2 pairs, in VIII and IX, those in IX one and a half (P) to twice (H) the length of those in VIII; each with an ovoid ampulla, short poorly demarcated duct and wide clavate dorsolateral diverticulum. (All previous data for H and P). Total length of right spermatheca of IX (H) = 2.7 mm; ratio total length: length duct = 9.0; ratio length: length diverticulum = 3.8.

MATERIAL EXAMINED: Lord Howe Island (no further data) — Holotype (W4563), paratype 1 (BJ).

REMARKS: *S.* (*A*). *difficilis* differs from *S.* (*A*) *newcombei* in the paired female pores and questionably in a smaller number of setae per segment (reaching 32 in XX whereas 35 are reported by Gates, 1965, for post-clitellar segments in *newcombei*). It also lacks the

accessory genital markings described for *newcombei* so far as is known from the imperfectly clitellate available material. It is distinguished in the key from the other species of the subgenus on Lord Howe Island.

Spenceriella (Austroscolex) hollowayi n. sp.
Fig. 1, 4B, C, 6B, 7C. Table 2

1 = ?(postclitellar amputee), w (midclitellar) = 4.8 mm, s = ?. Pigmentless in alcohol. Prostomium tanylobous, parallel sided, bisected by median furrow. First dorsal pore 4/5. Setae irregularly spaced, slightly more closely spaced laterally than dorsally and ventrally; numbers of setae per segment 43 in XII (H); 39, 41, 42 in XX (H, P1, 2); 41, 40, fifteen segments from the caudal end (P1, 2); a and z lines approximately straight until near the caudal extremity where they become very irregular; anteriorly with wide and approximately equal ventral and dorsal interruption of the setal circlet; no appreciable interruption caudally; setae a and *b* absent in XVIII. Clitellum annular, 1/3 XIII (ventrally), 2/3 XIII (dorsally) — XVII, intersegmental furrows strongly indicated; setae less distinct than elsewhere; dorsal pores obscured. Male pores in XVIII, considerable transverse slits, each on a low but distinct transversely elliptical porophore, filling the equatorial third of the segment, centred very slightly lateral of *b* lines of adjacent segments; 1.48, 1.24, 1.50 mm, 0.10, 0.11, 0.12 circumference apart (H, P1, 2). Accessory genital markings: a pair of dome-shaped papillae, slightly wider than long, in X, XI and XII, each papilla occupying the setal annulus and anterior third of the segment, the setae traversing its posterior flank, and with a dark porelike centre in c line (X), *bc* (XI) or *b* (XII). Similar but smaller markings in XXI and XXII, with centres in *ab* and *a* respectively, (right side only in XXII, H). Paratype 1 has the paired postclitellar accessory genital markings in XXI only (amputee with forebody to XVI missing); paratype 2 has paired markings in XX and XXI but has also a pair (similarly conjoined) in XVII, with presetal centres approximately in *a* lines (forebody to XVI missing). Female pores an inconspicuous pair in XIV, shortly anteromedian to setae a. Spermathecal pores 2 pairs, in 7/8 and 8/9, each a small transverse slit in *bc* on an inconspicuous papilla; 1.24 mm, 0.10 circumference apart (H).

Septa 7/8-12/13 strongly thickened; 9/10 strongest. Dorsal vessel single, not traceable (broken?) in front of segment VI. Dorsoventral commissurals in VI-IX very slender, though valvular, and each giving off a lateral branch before the junction with the ventral vessel. Hearts in X-XII thicker than preceding commissurals but not large.

Gizzard in V, wide but short, compressible and only moderately muscular. Oesophagus virtually suppressed in VI; moniliform (segmentally widened) in VII-XIV, with circumferential vascular striae and internal rugae which in XII are almost lamellae, but no extramural calciferous glands; narrow and covered with yellowish chloragogue in XV and 1/2 XVI. Intestinal origin 1/2 XVI; typhlosole, muscular thickening and caeca absent. Nephridia astomate (?) avesiculate, exonephric micromeronephridia commencing in II, forming a parietal band in transverse single file in each segment, approximately 15 on each side in the posterior region of the oesophagus; no tufted nephridia present. In the postprostatic region, at least, each nephridium has a minute nephrostomal funnel which lies in the same segment as the body of the nephridium (H). Caudally 15 nephrostomes counted on each side per segment, lying shortly behind the anterior septum; no preseptal funnels demonstrated. Ventral nephridia forming an exonephric (?) group of several on each side but no megameronephridia present. Dorsal nephridia adherent to the intestine and apparently individually enteronephric; no longitudinal ureters demonstrable (P2).

Holandric; large iridescent sperm funnels in X and XI; very small racemose seminal vesicles, with few loculi, on the posterior septa of IX and X and the anterior septum of XII. Ovaries, plicate webs with many chains of large oocytes, and funnels in XIII; ovisacs absent.

Prostates, a pair in XVIII-XIX, superficially racemose, the left one trilobed, the right one bilobed by deep transverse incisions (H), or irregular in outline but linear (P1); the very slender, long muscular duct arising considerably posterior to the anterior limit of the gland (H, P1); vas deferens joining at its junction with the duct. Serial sections show only a single very narrow (eccentric) lumen in each lobe; this has a distinct lining epithelium; side branches are not visible but, from the great thickness of the surrounding glandular tissue, are presumably present; continuity of the lumina between the different lobes was not demonstrated but in view of their single nature this appears more probable than separate origin of each lumen from the muscular duct; the gland therefore is taken to be tubuloracemose, as the linear form in P1 also suggests. Penial setae absent. Spermathecae 2 uniform pairs, in VIII and IX; ampulla ovoid, wider than long; duct less than half as wide though stout, joined dorsolaterally at its junction with the ampulla by a wide stalked, clavate, inseminated diverticulum which in the four spermathecae is curved around the duct; length of right spermatheca of IX = 1.5 mm; ratio total length: length of duct = 2.6; ratio length: length of diverticulum = 1.5 (H).

MATERIAL EXAMINED: Summit of Mt. Gower, Lord Howe Island; collector G. Holloway, Oct 1971 — Holotype, paratype 1 (W6598), paratype 2 (BJ).

REMARKS: *S. (A). hollowayi* differs from *S. (A). newcombei* in the greater number of setae per segment, in the paired female pores and in the configuration of the accessory genital markings. It is distinguished in the key from the other species of the subgenus on Lord Howe Island.

Spenceriella (Austroscolex) howeana n. sp.

Fig. 1, 4A, 6E, 7D. Table 3

1 = 24-35 mm (mean 31.6 mm); w (midclitellar) = 1.5-2.0 mm (mean 1.6 mm), s = 84-97 (mean 89) (H, 4 paratypes). Form dorsoventrally depressed. Lacking appreciable secondary annulation. Purplish pigmentation present dorsally (H, 9 paratypes). Prostomium epilobous, varying from 1/2-5/6, usually with a faint middorsal groove (H, 6 paratypes). First dorsal pore 5/6 (H, 5 paratypes, within H and P8 an imperforate rudiment in 4/5). Setae commencing on II; numbers per segment 17, 19, 16, 18, 20 on XII; 21, 22, 17, 19, 20 on XX; 17, 19, 23, 22, 20 at fifteen segments from posterior end (H, P1, 17-19); *aa* a clearly recognizable interruption in the setal circle (÷ 2 *ab*); zz a very wide interruption, so wide in the forebody that only setae *y* and *z* are visible dorsally, *zy* being here much wider than in the hindbody although *zz* ÷ 2 *zy* throughout the body; setae *a*, *b* (and *c*?) absent in XVIII; *a* and *z* lines approximately straight; the two dorsal setae (*yz*) on each side conspicuously enlarged in IV or V to IX or rarely to X, the other setae of each segmental circle decreasing in size ventralwards. Lengths and greatest widths of seta *z* (P1); 290 µm, 36 µm (V); 360 µm, 50 µm (VI); 430 µm, 50 µm (VII); 400 µm, 50 µm (VIII); 360 µm, 50 µm (IX); and of seta *x* in IX 300 µm, 32 µm; scattered cicatricing well developed on the enlarged setae, less apparent on normal setae.

Nephropores not visible. Clitellum annular, tumid but not protuberant, embracing XIII, 1/2 XIII-1/n XVII, 1/2 XVII or XVII; dorsal pores and intersegmental furrows obscured at full development; small slit-like combined male and prostatic pores a pair on XVIII slightly lateral of s.1.2 on papillae which occupy the length of the segment but are indistinctly demarcated laterally (H, 5 paratypes) pores 0.90 mm, 0.20 circumference, apart (H); means for 5 specimens (H, P1, 17-19), 0.93 mm (range 0.84-1.08 mm), 0.18 circumference (range 0.15-0.20). Accessory genital markings (holotype) indistinct presetal pits or circular glandular patches lateral of setal lines 3 in IX and X (P5); lateral of s.1.2, 3 or 4 in XI (H, P5, 6, 9); near s.1.2 or 3 in XII (H, P6, 9); between s.1.1 and 2 or in s.1.2 in XVII (H, P2, 3, 4, 9); in or lateral of s.1.2 in XIX (P4, 9); and between s.1.2 and 3 and in s.1.2 in XX (H, P4) or no genital markings apparent. Female pores small but moderately conspicuous shortly in front of the setal arc of XIV and almost contiguous midventrally to almost as far laterally as s.1.1 (H, 7 paratypes).

Spermathecal pores 2 pairs, in 7/8 and 8/9, minute and visible only when the intersegmental furrow is held open, very slightly lateral of s.1.3 or in 4 (H, P2, 3, 5-8) or lateral of s.1.2 (P9); the last pores 0.94 mm, 0.23 body circumference, apart (H); means for 5 specimens (H, P1, 17-19) 1.18 mm (range 0.94-1.28 mm), 0.26 circumference (range 0.20-0.36).

Internal anatomy (Holotype, P1 and, where mentioned, schizoparatype).

Septa 5/6 and 6/7 thin; 7/8 slightly thickened; 8/9 and 9/10 moderately strong; 10/11-14/15 and to a lesser extent several succeeding septa appreciably thickened. Last pharyngeal glands, large paired masses in VI investing the dorsoventral commissural vessels. A slender subneural vessel apparently present, adherent to the parieties but not demonstrated with certainty. A pair of large latero-parietals originating from the vascular plexus of the floor of the oesophagus in XIII and extending posteriorly to the vicinity of the prostate glands.

Gizzard moderately large but readily compressible, in V. Oesophagus in IV narrower and not modified as a proventriculus. Oesophagus swollen and with circumferential vascular striae in XI and XII, especially so in XIII and XIV; internally with vascular rugae in XI-XIV, which are thin and high in XIII in P1, but extramural calciferous glands absent; narrower and less vascular in XV. In the schizoparatype the oesophagus is not especially enlarged in XIII but in XIV is greatly distended dorsally and has a very wide blood sinus in the dorsal wall and lesser sinuses in the ventral wall; these sinuses are not present elsewhere in the oesophagus; the floor of the dilatation in XIV is rugose, but not more so than in other segments, while the roof is internally smooth. Intestine beginning, with definite oesophageal valve, in XVI; in this segment and XVII wider than but otherwise morphologically similar to the oesophagus; typhlosole and caeca absent. Nephridia avesiculate micromeronephridia throughout, commencing in II; numerous in each segment; in caudal segments with a preseptal funnel on each side near the ventral nerve cord, additional funnels detectable on lateral nephridia in paratype 1; nephridia in the intestinal region attached to septa; pre-intestinal nephridia integumentary; pharyngeal nephridia absent; no enteronephry demonstrable but absence requiring confirmation from appropriately preserved material. Testes, sperm masses and large iridescent sperm funnels free in X and XI; racemose seminal vesicles in IX and XII, the posterior pair the larger. Ovaries, large folded thick laminae with many large oocytes, and funnels in XIII; racemose ovisacs in XIV. Prostates racemose, i.e. dorsoventrally depressed elongate structures, the posterior portion of which is joined to the anterior portion by a narrow neck and is approximated to it in such a way that the gland as a whole appears superficially to form a broad rectangle; the surface not notably lobulated but the external curved muscular duct is seen in the schizoparatype to bifurcate within the gland. Penial setae absent. The intracoelomic portion of each enlarged seta in the forebody invested in a conspicuous glandular mass. Spermathecae 2 pairs, discharging anteriorly in VIII and IX, each with an ovoid ampulla and slightly shorter ectally tapering duct which receives a single lateral clavate diverticulum at midlength, the diverticulum embracing the oesophagus and visible dorsally; size of spermathecae approximately uniform; length of left spermatheca of IX (holotype) = 0.68 mm; ratio total length: length duct = 2.3; ratio total length: length diverticulum = 1.8.

MATERIAL EXAMINED: *6*, 31°35′03½″S, 159°04′56″E. Mt. Gower ridge, close to stream; leaf litter in places, elsewhere dense moss covering trees; — Holotype and paratype 1 (W6593); *7* 31°35′04″S, 159°04′55″E. Mt. Gower ridge, in a layer of soil beneath moss on a tree trunk; — P20 and 5 further specimens (W6594); *11* 31°35′08″S, 159°04′47″E. Mt. Gower ridge, in the leaf of a short palm, *Hedyscepe canterburyana*, 1 metre off the ground; — P2-4, 10-18 (W6595); *13*, 31°35′01″S, 159°04′49″E. At foot of small stream running at right angles to Mt. Gower ridge, in the base of fronds of the palm *Lepidorrhachis*; other vegetation *Dracophyllum fitzgeraldii, Passiflora edulis*; tree-ferns; — P5-8 (BJ); *14*, 31°35′02″S,

159°04'50"E. Up stream running at right angles to Mt. Gower ridge, dense vegetation, damp conditions; in leaf litter; — P9 (W6596); Lord Howe Island (no further data) — P19 (4560), P21-23 (W4565); Lord Howe Island, collector Saunders — 1 (W6597 ex W1509).

REMARKS: *Spenceriella (Austroscolex) howeana* is distinguishable from the other species of the subgenus by the very large setal interval zz (13 to 26% of the circumference in 5 measured specimens), the conspicuous enlargement of setae *yz*, and the configuration of the genital markings.

Spenceriella (Austroscolex) saundersi n. sp.

Fig. 1, 5A, B, 6F, 7B. Table 3

1 = 65, 105 mm; w (segment XV) = 5.3, 6.2 mm; s = 110, 109 (H, P1). Greyish brown (pigmented) in alcohol with clitellum (P3) light brown. Slightly flattened ventrally. Prostomium epilobous, open (?), ½, not canaliculate. Peristomium bifid (H) or (P1) not bifid ventrally. First dorsal pore 4/5 (?) (H, P1). Setae commencing on II; 53, 55 on XII, 56, 61 on XX; 42, 49, fifteen segments from posterior end (H, P1); *aa* and zz only a narrow break in the setal circlet (÷ 2*ab* and 2*zy*, respectively); *aa* narrower but a just appreciable break; zz an inappreciable break, caudally; setae 1-6 (*a-f*) absent in XVIII; a and z lines approximately straight; no setae notably enlarged; setal intervals progressively increasing dorsalwards. Nephropores not visible. Clitellum developed (H) or (P1, 2) rudimentary; annular in XIV-XVII but possibly more extensive when fully developed; well developed in ½ XIII-XVII in P3. Combined male and prostatic pores a pair of small but distinct orifices on XVIII in setal lines *b* relative to adjacent segments; with marginal tumescence which only in the holotype constitutes a porophore though then indistinct; pores 2.16, 2.28 mm, 0.16, 0.16, body circumference apart (H, P1, 2). Small disclike accessory genital markings basically in an inner and an outer ventral series, that is, 4 longitudinal rows, in IX-XII; the outer row approximately in setal lines 7, the inner row in setal lines 2-3, the markings post setal in IX in which only that of the outer row is present on the left and only that of the inner row on the right; in X pre- and post-setal in the outer row but only presetal in the inner row, that of the right inner row being transversely duplicated, that of the left inner row single but accompanied by an anterior supernumerary marking between it and the outer row; in XI pre- and post-setal in the outer row and presetal only, in the inner row; in XI!, presetal only, in the outer and inner row (H). The accessory genital markings restricted in P1 to a pair of postsetal disclike markings in X, in setal lines 7 and in XI in setal lines 9-10 with a suggestion of similar markings posteriorly in XVIII, immediately posteromedian to the male pores; accessory genital markings absent in P2 and 3. Female pores inconspicuous, a pair immediately median to a lines, midway between the setal arc and anterior border of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, each a minute orifice with a crescentic anterior lip forming a half-papilla concealed in the intersegmental furrow, in setal lines 6 or 7 (H, P1) last pores 1.8, 2.56 mm, 0.19, 0.20 body circumference apart (H, P1).

Septa 8/9-13/14 strongly thickened; 10/11 (H), 11/12 (P1) — 13/14 the strongest. No subneural demonstrable.

Gizzard recognizably differentiated but no wider than the adjacent oesophagus and with rudimentary muscularization, in V, concealed in the penultimate last septal glands. Last septal glands in VI. Oesophagus in IV equally wide and forming a proventriculus. Oesophagus simple in VI, segmentally widened in VIII-XIV; not especially vascular in VII and VIII but with obvious circumferential vascular striae and conspicuous internal radial lamellae in VIII-XIV, though extramural calciferous glands are absent, and chloragogenous in XV-½ XVI; intestine originating at ½ XVI, here and in XVII moniliform and resembling the oesophagus but only villous, not lamellate internally; typhlosole, muscular thickening and caeca absent. Nephridia avesiculate micromeronephridia throughout, commencing in II;

dense lateral bands of moderately to very numerous tubules in II and III but neither tufting nor enteronephry demonstrable, lateral bands also especially dense in XIV-XVIII; numerous intrasegmental nephrostomal funnels demonstrable on each side in each segment in IV posteriorly, in both the oesophageal and intestinal regions. Testes and large convoluted sperm funnels free in X and XI, only the funnels in X iridescent, transversely elongate tortuous racemose seminal vesicles with many discrete loculi, in IX and XII, the anterior pair the larger. Ovaries rudimentary (H) or moderate-sized webs with several conjoined strings of large oocytes, (P1); funnels in XIII (H, P1); loculate sacs (ovisacs?) near the oviducts on the anterior septum of XIV (P1) or absent (H). Prostates racemose, the muscular duct branching on entering the gland each gland restricted to XVIII and consisting of a subrectangular, flattened anterior lobe and a more slender, elongate irregular posterior lobe, the two lobes meeting at the muscular duct from which a branch passes into each lobe; the two lobes separate, or conjoined by connective tissue. Vas deferens joining the gland at the junction of this with the muscular duct; penial setae absent; no glandular masses associated with somatic setae (H, P1). Spermathecae 2 pairs, discharging at the anterior margin of VIII and IX, each with a subspherical ampulla and a slightly shorter moderately slender well demarcated tubular duct which is joined slightly ectal of its midlength by a single lateral (inseminated) clavate diverticulum, the stalk of which is almost as wide as the spermathecal duct; the diverticulum projecting laterally, not embracing the oesophagus; size of spermathecae uniform; length of left spermatheca of IX = 0.95, 0.85 mm ratio total length: length duct = 1.9, 2.9; ratio length: length diverticulum = 0.7, 1.1 (H, P1 respectively).

MATERIAL EXAMINED: Lord Howe Island (no further data) — Holotype (W6599 ex W4560); Lord Howe Island, collector Saunders — P1 (BJ ex W1509), P2, 3 (W6600 ex W1509); 7 (W6601 ex W4563); Lord Howe Island, collectors "E.J. & W." — P4 (W4562).

REMARKS: *S.* (*A*). *saundersi* differs from *S.* (*A*). *newcombei* in the greater number of setae per segment, in the paired female pores and in the configuration of the accessory genital markings when these are developed. It is distinguished in the key from the other species of the subgenus on Lord Howe Island.

The five specimens (W4563, no data) are excluded from the above description of *S.* (*A*). *saundersi* though they agree with it in all stated respects excepting the following. They are larger (in a selected specimen 1 = 172 mm, w (XV) = 8.0 mm, s = 131). Although setae 1-6 are absent in XVIII, as in *saundersi*, the male pores are consistently in setal lines 4 as are the spermathecal pores, this difference occurring despite similar numbers of setae (54 on XII, 58 on XX and caudally). The ventral distance between the male pores though greater (2.48 mm) is a smaller proportion of the circumference (0.11) than in *saundersi* and the same is true for the spermathecal pores (3.12 mm, 0.14 circumference apart). Spermathecae are larger (length 1.6 mm; ratio length: length duct 1.4; ratio length: length diverticulum = 2.3). Differences in the setal ratios are doubtfully significant. As the spermathecal diverticula are inseminated, the absence of a clitellum is presumably due to post-copulatory regression.

A further specimen (W4562, no data) excluded from the type-series of *saundersi* resembles these five specimens in size, in location of male and spermathecal pores in setal lines 4, and has even larger spermathecae (length 2.3 mm, ratio length: length duct 3.0; length: length diverticulum 1.9). It agrees closely with *S.* (*A*). *saundersi* in setal ratios, however, and is probably conspecific with the type-series.

The ratio of separation of male pores to the circumference (2.52 mm, 0.13 circumference, apart) in this specimen is intermediate between the *saundersi* and the five W4563 specimens and its spermathecal pore ratio (3.04 mm, 0.13 circumference, apart) is close to both series. This specimen links *S.* (*A*). *saundersi* and the five specimens and suggests that the latter represent a population which, though morphologically somewhat distinct from the type-series, is conspecific with it. Separate specific status cannot be ruled

out with certainty on present evidence, however, expecially as the possibility exists of a distribution of accessory genital markings different from *saundersi* if the specimens had been clitellate.

Genus Amynthas Kinberg, 1867
Amynthas diffringens (Baird, 1869)

Megascolex diffringens Baird, 1869: 40

Pheretima heterochaeta. — Michaelsen, 1909: 189

Pheretima divergens var. *yunnanensis* Stephenson, 1912: 274

Pheretima mirabilis. — Gates, 1934: 260 (*fide* Gates, 1972)

Pheretima diffringens. — Gates, 1972: 177

Amynthas diffringens. — Sims & Easton, 1972: 214

TAXONOMIC NOTE: Synonyms of this frequently recorded and almost cosmopolitan species are listed above. The account of Gates (1972) is the most comprehensive. Sims and Easton (1972) in their excellent computer analysis of *Pheretima* justify transfer of *diffringens* to a reinstated *Amynthas* and give an exhaustive list of nominal species which they include in a *diffringens* group. The single specimen in the material from Lord Howe Island under investigation conforms to genus *Amynthas* in the key to the genera of the *Pheretima* complex of species given by Sims and Easton in having a cylindrical body with evenly distributed setae, intestinal caeca arising at the anterior margin of segment XXVII and no copulatory pouches (but here no prostates) at the male pores. It agrees with the *diffringens*-group in the key to species and nominal species-groups of *Amynthas* in having 4 pairs of inter-segmental spermathecal pores, in 5/6-8/9, and in being holandric. The following account of the excretory system, in so far as it can be elucidated in the single somewhat macerated specimen, appears to be the first description with any detail for this species. Nephridia all avesiculate; pharyngeal tufts (? specimen anteriorly macerated); in the oesophageal region with numerous, scattered, astomate parietal micromeronephridia which are especially numerous and densely crowded in the clitellar segments; anterior intestinal nephridia numerous, rather large (enteronephric?), dependent from the posterior face of the septum and each (?) with a preseptal nephrostomal funnel the long, very slender neck of which extends far in front of the septum (at least 12 funnels counted on one side in a selected segment); minute parietal micromeronephridia also present in these intestinal segments, each apparently corresponding with a setal follicle and with its duct entering the body wall presetally. By XXV, or possibly more anteriorly, nephridia are added on the anterior faces of the septa with funnels in the same segment as the nephridial bodies, in addition to the post septal nephridia which retain their preseptal nephrostomes. In caudal segments the preseptal nephridia continue to have funnels on the same side of the septum but the postseptal nephridia, which seem more sparsely developed, have postseptal nephrostomes, the arrangement of these two sets of (enteronephric?) septal nephridia therefore being as described by Bahl (1919) for *Metaphire posthuma*. A difference from *M. posthuma* is that at least some of the parietal (exonephric) nephridia in caudal segments have funnels.

MATERIAL EXAMINED: *40*, 31°33′15″S, 159°05′57″E. On the track to Boat Harbour, by a creek; *Pandanus forsteri, Guioa coriacea, Howea forsterana, H. belmoreana, Linociera quadristaminae*; —3 (W6602).

ZOOGEOGRAPHIC AFFINITIES AND EVOLUTION OF THE EARTHWORMS OF LORD HOWE ISLAND

The indigenous earthworms of Lord Howe Island, all of which are assignable to the family Megascolecidae, are morphologically and, it is inferred, phylogenetically more closely related to the Australian fauna than to that of any other region. One genus, *Diporochaeta* has its type-species in New Zealand but the genus is predominantly Australian. It represents the sole link between Lord Howe Island and other regions, excepting the widely transported Oriental species, *Amynthas diffringens*. The six indigenous genera of the island are all members of the subfamily Megascolecinae. They are *Diporochaeta, Plutellus, Paraplutellus, Pericryptodrilus* (Tribe Perionychini), *Eastoniella* (Tribe Dichogastrini) and *Spenceriella* (Tribe Megascolecini?).

PARAPLUTELLUS AND PLUTELLUS

Despite their undoubted Australian affinities, three of the six genera (*Paraplutellus, Pericryptodrilus* and *Eastoniella*) are known only from the island. Of these, *Paraplutellus* is exceedingly close to, yet satisfactorily distinct from, *Plutellus* s. strict. which has only three known species, one in rainforest in coastal New South Wales, one on Lord Howe Island, and one of doubtful origin. The discovery of an endemic species of *Plutellus* on the island in the present study raises the possibility of evolution of the two species, *Plutellus hutchingsae* and *Paraplutellus insularis* on the island from a common ancestor, or speciation there of one from an isolated population of the other. The alternative would be to accept separate invasion of the island by each species or by two distinct ancestral species. Unless these plutelloids have a special propensity for transoceanic dispersal the probability of the double invasion when many species from eastern mainland Australia have failed to invade would seem low. The North American plutelloid genus *Argilophilus* has a salt tolerant species *A. marmoratus* in estuarine conditions in New South Wales (personal observations) and all earthworms from so small an oceanic island as Lord Howe Island must presumably have greater salt tolerance than is usual in earthworms. But even if such salt tolerance were presumed for the plutelloids of Lord Howe Island, a double landfall on so small an island would seem improbable. Whether the two species have speciated from a common ancestral species or not, and whether such speciation occurred on the island or elsewhere, their very close relationship is unquestionable. Which is the more primitive (plesiomorphic) is difficult to ascertain. The more widely distributed, more numerous, and in most habitats presumably more efficient *Paraplutellus* appears the more derived: it has lost the gizzard; the oesophagus has extended by one segment (intestinal origin in XVI as against XV in *Plutellus*); and anterior nephropores are in *d* lines in segments II-IV whereas they are in *d* only in II of these segments, in *Plutellus hutchingsae* (though alternation from *d* to *b* occurs in V or VI posteriorly). Occurrence of pores in *d* is here considered a modification of location in *c* which is the basic or common condition in Australian perionychins. In this respect modification has proceeded further in *Paraplutellus insularis* than in *Pl. hutchingsae*. Restriction of calciferous glands to a single pair in XIII in *Paraplutellus*, in contrast with four pairs, in X-XIII, in *Plutellus* and three to five pairs ending in XIII in the related *Heteroporodrilus*, may also be a reduction from a previously more extensive series. It is here suggested that *Paraplutellus* is, in Hennig-Brundin terms, the apomorph sister-group of *Plutellus* and that it evolved on the island from a stock which, contrary to the principles of those workers, would have been itself assignable to *Plutellus*.

PERICRYPTODRILUS

The monotypic genus *Pericryptodrilus* appears on initial examination to be no more than a perichaetine (multisetose) form of the eastern Australian and Tasmanian genus *Cryptodrilus* but restriction of nephrostomes to the intermediate rather than the ventral

row of nephridia, in addition to the perichaetine condition, at present warrants generic status. Its affinities nevertheless lie with the Australian rather than any other fauna.

EASTONIELLA

The genus *Eastoniella* is, likewise, known only from Lord Howe Island while having undoubted Australian affinities. Location of the oesophageal gizzard in its two species as far back as segments VIII or IX is a highly evolved condition, the gizzard having reached segment VIII elsewhere in the Megascolecidae in the Oriental genera *Pleionogaster* and *Pheretima* s. lat., which show only distant affinities with *Eastoniella*. The multi-lipped, and sometimes exceptionally large, paired nephrostomal funnels in *Eastoniella* add to its distinctiveness but the posterior caudal nephridia and general anatomy in the genus are those of an Australian dichogastrin and its descent from a form placeable in the eastern Australian *Megascolides* is easily envisaged.

DIPOROCHAETA

The genus *Diporochaeta* is represented on Lord Howe Island by a single species which is unknown elsewhere. The genus is restricted to New Zealand and Australia with doubtful representation in Southern India. It is the dominant genus in Tasmania (23 species), though its largest representation is in Victoria (33 species, synonymy to be investigated), and it has some representation on high ground in New South Wales (3 species on Mt. Kosciusko of which one also occurs in Victoria) and a few northerly outliers, in North Queensland (7 species), mostly in the Cairns-Atherton Tableland area, this area being regarded as a refuge area. Affinities of the Lord Howe Island species appear to lie with the southeastern Australian species. In New Zealand most species are restricted to the west coast and there seems a possibility of relatively recent invasion from Australia. Lee (1959) considers that most species have probably had their present distribution in New Zealand only since the end of the Pleistocene glaciation. Occurrence on Lord Howe Island may be due to the same transoceanic dispersal and it will be interesting to investigate whether Australian members of the genus are euryhaline.

SPENCERIELLA AND THE ORIGIN OF PHERETIMA

SPENCERIELLA (AUSTROSCOLEX)

Inclusion of the subgenus *Austroscolex*, erected for three species from Lord Howe Island and a fourth from Queensland, in the south-eastern Australian and Tasmanian genus *Spenceriella* represents a further, major link between Lord Howe Island and Australia. The structure of the excretory system in both subgenera of *Spenceriella* raises the possibility of relationship of this (wholly?) Australian genus with the predominantly Oriental genus *Pheretima* s. lat., however. Bahl (1947: 131), in his impressive review of excretion in the Oligochaeta, states that in the (septal) nephridia of *Pheretima* the funnel and body lie in the same segment whereas in all other earthworms the funnel is preseptal. The only other demonstration of such intrasegmental nephrostomes appears to be that for *Spenceriella* (v. Jamieson, 1974b), confirmed in the present study. The excretory system in *Pheretima* differs from that in *Spenceriella* in location of those nephridia having intrasegmental funnels on the anterior and posterior septa of the intestinal segments whereas in *Spenceriella* the stomate nephridia are parietal. The shared possession of intrasegmental nephrostomes would not be sufficient to suggest a closer relationship between the overwhelmingly extra-Australian *Pheretima* (with only one described indigenous Australian species) and *Spenceriella*. It may, nevertheless, reflect a special relationship as the external facies of some *S*. (*Austroscolex*) species are remarkably like those which have been thought distinctive of *Pheretima*. Gates (1965) in redescribing *S*. (*A*). *newcombei* (as *Megascolex*) remarked that it

"appeared externally to be referable to *Pheretima*", a reference, presumably, to the perichaetine condition, median unpaired female pore, and short clitellum, on XIV-XVI. *Pheretima* s. lat. differs significantly from *Spenceriella* in the far more complex arrangement of the various types of nephridia, described by Bahl (1919) for *Metaphire posthuma*, in location of the gizzard in VIII, both derived characters, and origin of the intestine in XV or XVI rather than constant origin in XVI of *Spenceriella*. Of the pheretimoid genera, *Metapheretima* most closely approaches *Spenceriella* in lacking intestinal caeca. Its nephridia, too, are closer to those of *Spenceriella* for an examination, in the present study, of non-indigenous Queensland material of *Metapheretima elongata* reveals, caudally, parietal (not septal) nephridia located anterior and posterior to the setal arc which have intrasegmental funnels. No intestinal enteronephry is demonstrable though this requires additional investigation in more and better preserved specimens. The stomate nephridia of *Metaphire posthuma* are septal and enteronephric and, as there is a row on both faces of each intestinal septum, intrasegmental funnels occur on both faces of the septum. This arrangement is here confirmed for further available non-indigenous Queensland material of the genus, *Metaphire javanica*. The nephridia of *Amynthas* (=*Pheretima*) *diffringens* are briefly described above in the taxonomic note on the species.

Spenceriella thus appears more than any other megascolecid oligochaete to deserve consideration as a representative of the ancestral stock from which *Pheretima* s. lat. arose.

The possibility of an Australian or at least Gondwanaland origin of *Pheretima* from a *Spenceriella*-like stock would raise the question of how *Pheretima* might have taken up its predominantly oriental distribution. The possibility that the oriental pheretimoid fauna is the result of a Tertiary invasion of the Oriental Region by Australian pheretimoids as the Indo-Australian tectonic plate brought Australia into its vicinity deserves consideration. The existence of an endemic pheretimoid, *Metaphire queenslandica*, in a Pleistocene refuge area of northern Queensland, together with the generic and specific diversification of pheretimoids in New Guinea, point to a long sojourn of pheretimoids in Australia and New Guinea. If *Spenceriella* is representative of an ancestral pheretimoid stock, its restriction to Australia militates against the alternative view that *Pheretima* first entered Australia from S.E. Asia, though such an origin of Australia's peregrine pheretimoids, such as *Amynthas diffringens*, is here accepted.

With regard to the four species of *Austroscolex* here recorded from Lord Howe Island, it is tempting to speculate that these have speciated on the island from a single ancestral species. The alternative, multiple invasion of the island, is not difficult to conceive but poses the question why numerous other species of the adjacent mainland were unable to colonise if *Spenceriella* was able to do so four times. The four species show close relationship in their very homogeneous internal anatomy and if accessory genital markings are absent (and no markings are known for *difficilis*) the species can only be separated on detailed comparison of such characters as setal counts, ratios of intersetal distances, distances between male and spermathecal pores and ratio of these to the circumference, a situation approaching that for *Drosophila* sibling species in the thoroughness of analysis necessary for discrimination of species, albeit in this case morphospecies.

DISTRIBUTION PATTERNS

Sampling on Lord Howe Island by Dr. Hutchings, though necessarily not exhaustive in the time available, has been extensive and the distribution patterns for the earthworm fauna which emerge must be considered real, with the reservation that only a single sample was taken from Mt. Lidgbird. The chief characteristic of the distribution is the apparent restriction of five species to the vicinity of the summit of Mt. Gower, one of the more natural and most isolated parts of the island. This restricted distribution contraindicates recent introduction of the species concerned, by transportation or otherwise, to the island. The

restricted Mt. Gower distribution is seen in *Diporochaeta plutelloides, Pericryptodrilus nanus, Eastoniella howena, Spenceriella* (*Austroscolex*) *howeana* and *S.* (*A*). *hollowayi. Plutellus hutchingsae* extends from Mt. Gower onto the saddle between this and Mt. Lidgbird, while *Paraplutellus insularis,* which we have seen could conceivably have originated from the ancestral stock of *Pl. hutchingsae,* is widespread on the island. *Eastoniella modesta* is known from an unspecified lowland area and an unrecorded locality. The distribution of *Spenceriella* (*A*). *saundersi* on the island is unknown. *Amynthas diffringens,* found in the vicinity of the boat harbour, is almost certainly introduced. Finally Lumbricidae, a holarctic family which it is not the purpose of this paper to identify, have been recorded from three localities (stations 22, 25 and 34) in or closely adjacent to cultivated areas.

The following abbreviations are used in the figures in this Record: ♀, female pore; g.m., accessory genital marking; ♂, male pore, ♂po, male porophore; np, nephropore; pr.d, prostate duct; pr.g, prostate gland; sp.p, spermathecal pore; v.d, vas deferens. Clitellum shaded. All by camera lucida.

Table 1 Intersetal Distances

	As % of circumference								mm
	aa	ab	bc	dc	dd	dc	cb	ba	u
Diporochaeta plutelloides									
XII Holotype	9.5	8.2	12.2	13.5	24.5	13.6	11.3	7.3	7.36
XX Holotype	8.4	7.4	9.9	11.2	33.5	12.3	9.9	7.4	8.07
Plutellus hutchingsae									
XII Holotype	9.7	8.3	12.6	12.6	20.4	14.1	13.1	9.2	7.23
Paratype 1	9.2	8.0	13.5	12.3	24.5	11.7	13.5	7.4	5.72
Paratype 5	8.7	8.7	13.6	12.4	22.3	13.0	12.7	8.7	12.92
mean	9.2	8.3	13.2	12.4	22.4	12.9	13.1	8.3	8.62
XX Holotype	8.3	8.0	15.0	13.6	23.3	10.7	13.1	8.0	8.24
Paratype 1	8.7	6.9	15.0	11.6	26.0	12.7	12.1	6.9	6.92
Paratype 5	7.5	5.5	15.4	13.7	25.3	13.3	12.5	6.8	11.70
mean	8.1	6.8	15.1	12.9	24.9	12.2	12.6	7.3	8.95
Eastoniella howeana									
XXV Holotype	8.5	5.0	10.6	10.4	38.7	9.7	11.1	5.8	29.50
Eastoniella modesta									
XX Holotype	15.1	6.2	10.7	10.7	34.4	7.6	8.9	6.5	14.55
XXV Paratype	9.6	5.5	10.0	7.9	44.3	7.4	9.8	5.5	26.14
mean	12.4	5.9	10.3	9.3	39.3	7.5	9.4	6.0	20.35

Table 2 Intersetal Distances

	As % of circumference					mm
	aa	ab	bc	zy	zz	u
Pericryptodrilus nanus						
XII Holotype	6.9	3.3	3.3	3.6	4.8	3.30
Paratype 2	7.3	4.7	4.4	3.5	4.4	3.16
mean	7.1	4.0	3.9	3.5	4.6	3.23
XX Holotype	7.5	3.8	3.8	3.8	6.9	3.20
Paratype 2	8.4	4.2	3.9	4.5	5.6	3.58
mean	8.0	4.0	3.9	4.2	6.3	3.39
Spenceriella (A) difficilis						
XII Holotype	13.0	3.3	3.4	2.9	12.3	11.05
Paratype	11.9	3.3	4.0	4.0	10.2	12.12
mean	12.5	3.3	3.7	3.4	11.3	11.59
XX Holotype	10.2	2.0	2.0	3.4	9.5	11.80
Paratype	10.4	2.4	1.8	3.6	10.0	12.30
mean	10.3	2.2	1.9	3.5	9.8	12.05
Spenceriella (A) hollowayi						
XII Holotype	5.92	2.5	2.0	2.8	5.4	12.16
XX Holotype	6.5	1.9	2.2	2.7	5.7	13.94
Paratype 1	10.3	2.2	2.8	3.1	5.5	11.64
Paratype 2	9.2	1.9	2.4	3.5	4.7	12.60
mean	8.7	2.0	2.4	3.1	5.3	12.72

Table 3 Intersetal Distances

		As % of circumference				mm
	aa	ab	bc	zy	zz	u
Spenceriella (A) howeana						
XII Holotype	9.8	5.8	5.4	8.3	19.6	4.08
Range (H, P1, 17, 18, 19) minimum	5.6	2.6	3.0	4.1	13.1	4.08
maximum	9.8	5.8	5.4	9.0	25.5	6.40
mean	7.6	3.9	4.1	7.4	19.0	5.01
XX Holotype	9.6	3.9	3.3	5.7	16.2	4.56
Range (H, P1, 17, 18 19) minimum	8.0	2.6	3.0	5.6	10.0	4.32
maximum	10.2	3.9	4.0	9.3	19.4	6.36
mean	9.0	3.3	3.6	6.8	13.4	5.26
Spenceriella (A) saundersi						
XII Holotype	4.0	1.5	1.6	2.7	9.5	10.08
Range (H, P1-3, W4562, 6601) minimum	3.2	1.2	1.2	1.5	3.1	10.08
maximum	4.9	1.8	1.6	2.7	9.5	23.50
mean	3.8	1.5	1.4	2.1	6.0	15.83
XX Holotype	3.9	1.5	1.3	1.7	4.8	13.44
Range (H, P1-3, W45062, 6601) minimum	3.0	1.1	1.2	1.6	2.8	12.72
maximum	5.5	1.8	1.4	2.5	7.5	19.84
mean	4.2	1.5	1.3	1.9	4.2	16.01

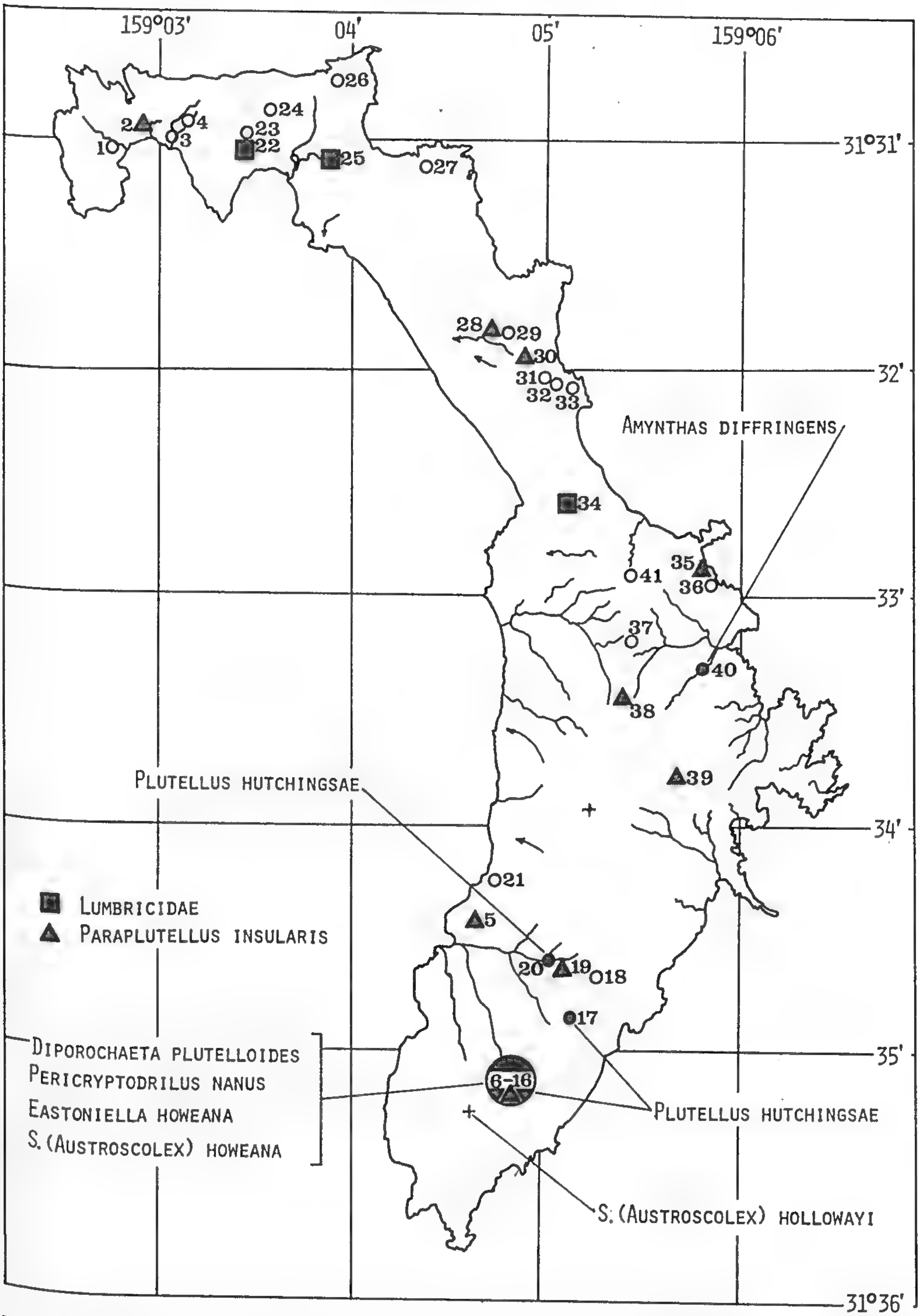

FIGURE 1. — Known distribution of earthworms (Megascolecidae and Lumbricidae) on Lord Howe Island. ● Present ○ Absent or unidentifiable (immature or incomplete).

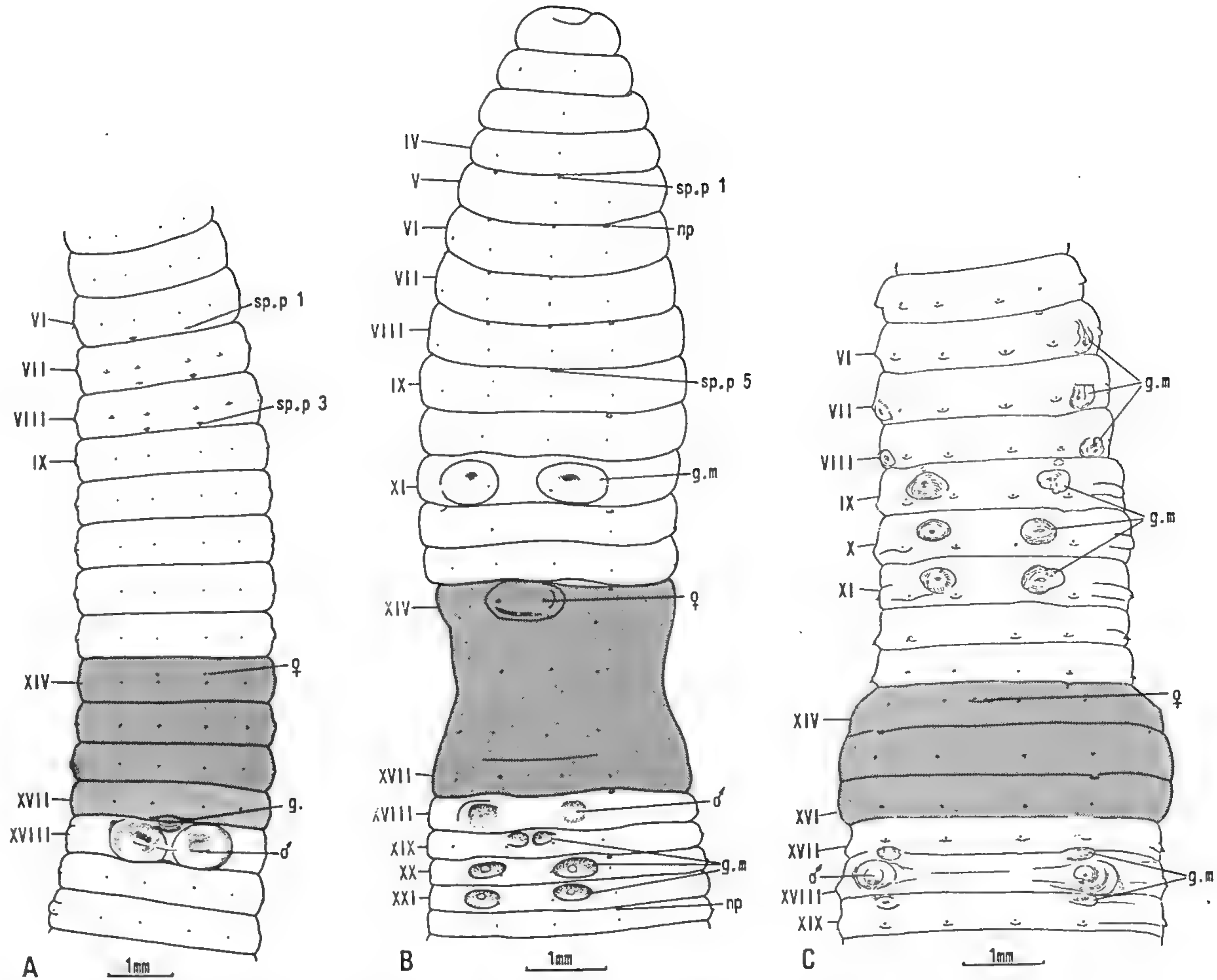

FIGURE 2. — Genital fields of: A, *Diporochaeta plutelloides*, holotype. B, *Plutellus hutchingsae*, holotype. C, Paraplutellus insularis (redrawn from Jamieson, 1972).

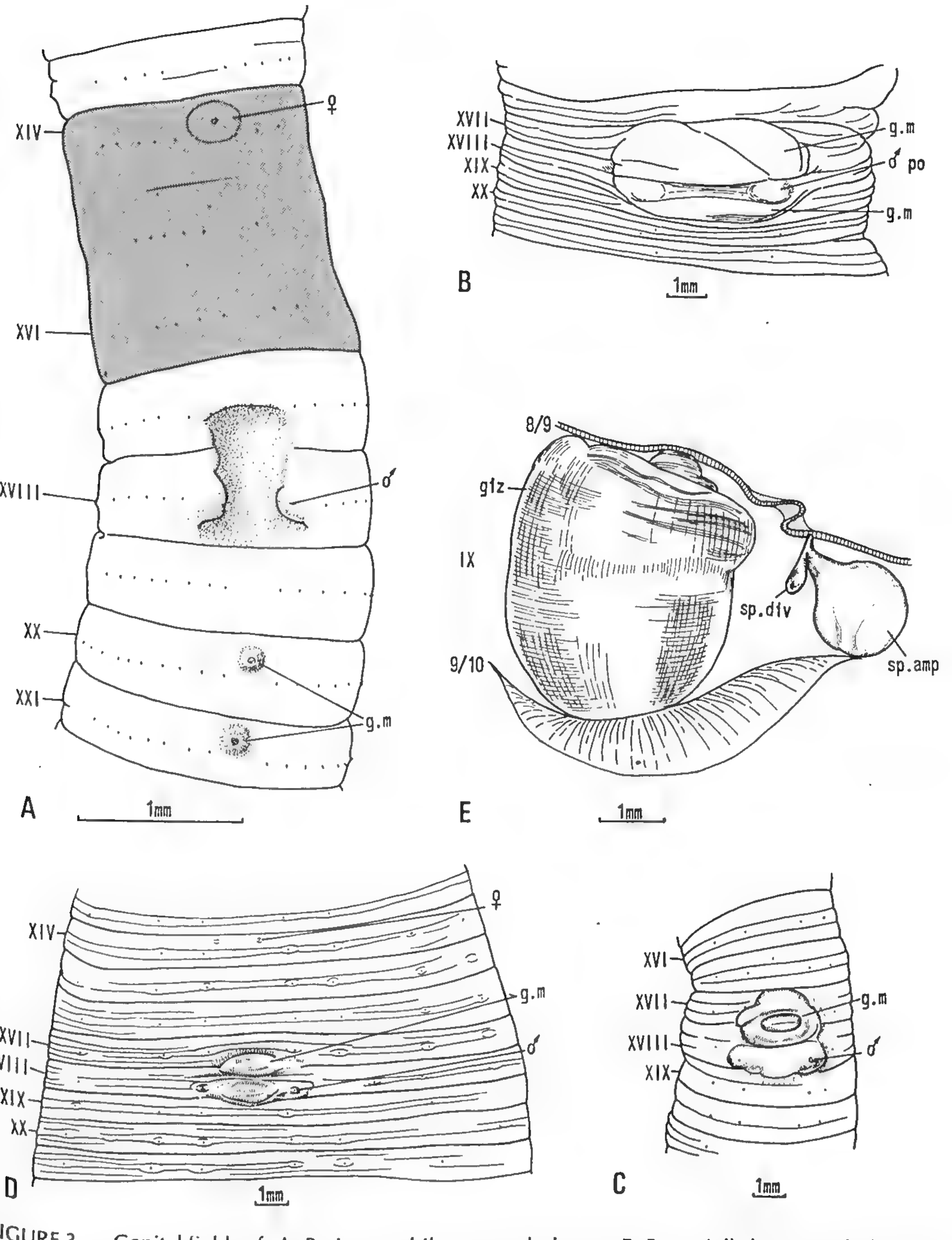

FIGURE 3. — Genital fields of: A, *Pericryptodrilus nanus*, holotype. B, *Eastoniella howeana*, holotype. C-E, *Eastoniella modesta*, C, holotype. D, paratype (opened and flattened), E, gizzard and right spermatheca *in situ*, holotype.

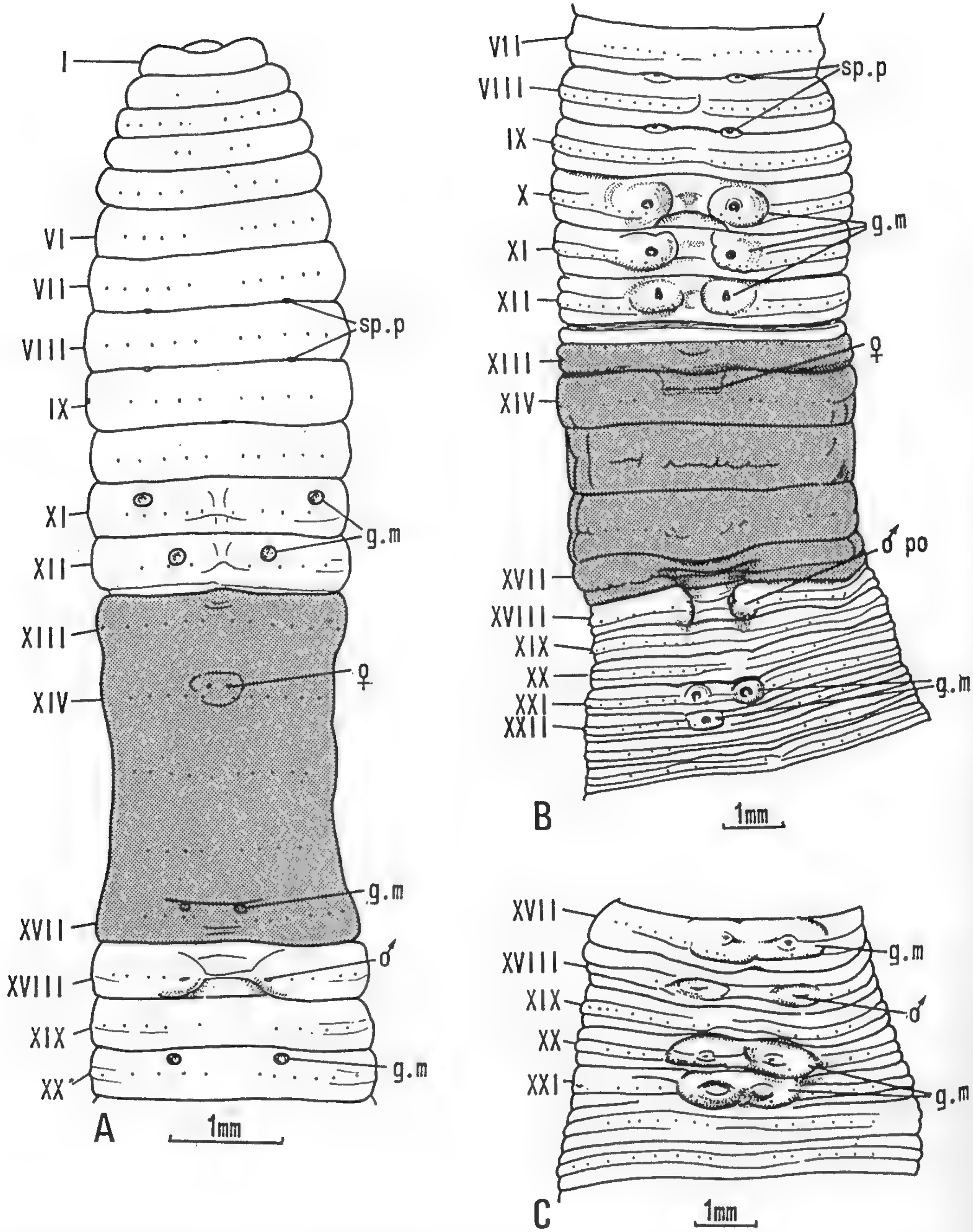

FIGURE 4. — Genital fields of: A, *Spenceriella (Austroscolex) howeana*, holotype. B, C, *S. (A). hollowayi*, B, holotype, C, paratype 2.

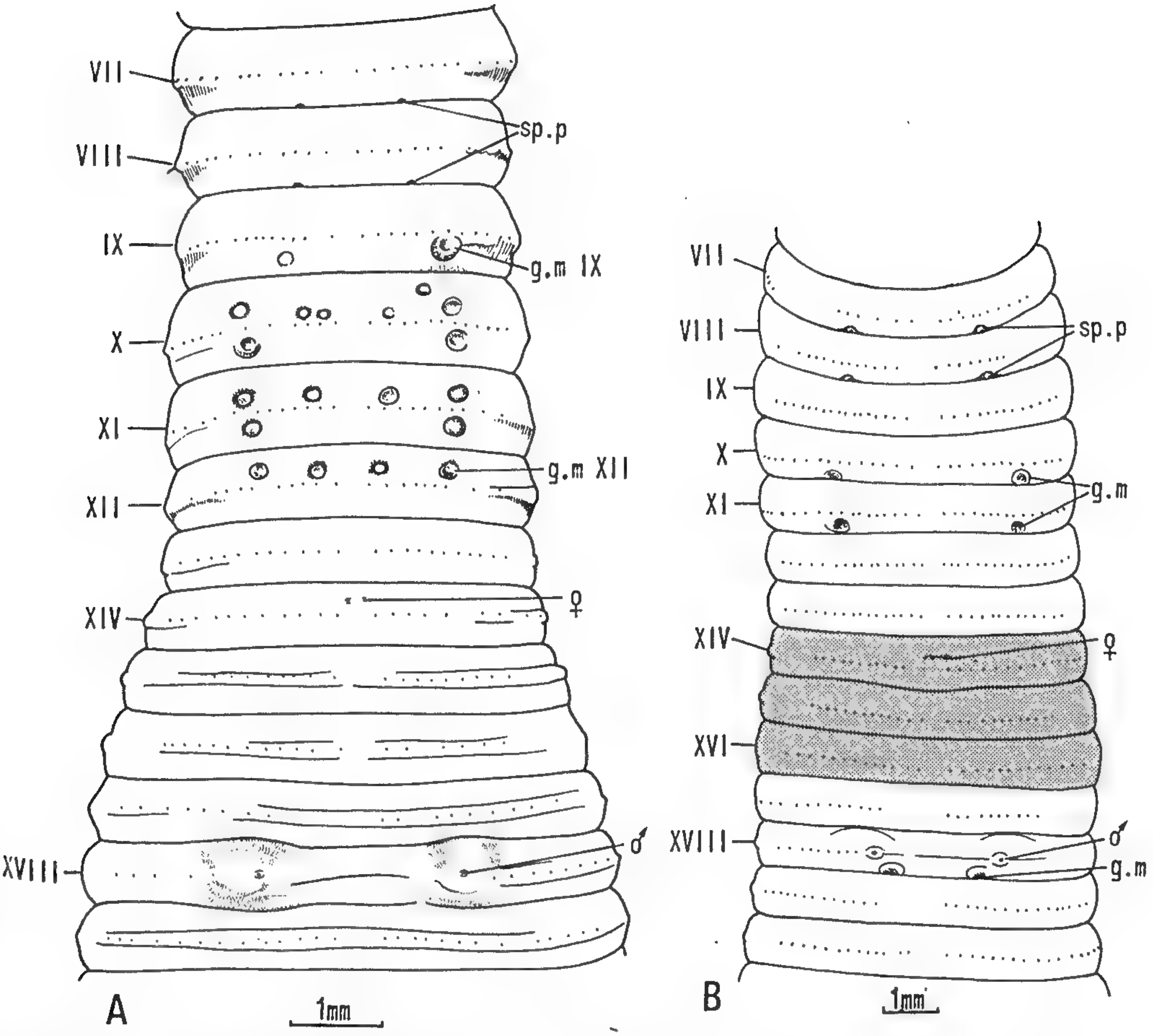

FIGURE 5. — Genital fields of *Spenceriella* (*Austroscolex*) *saundersi*, A, holotype, B, paratype 1.

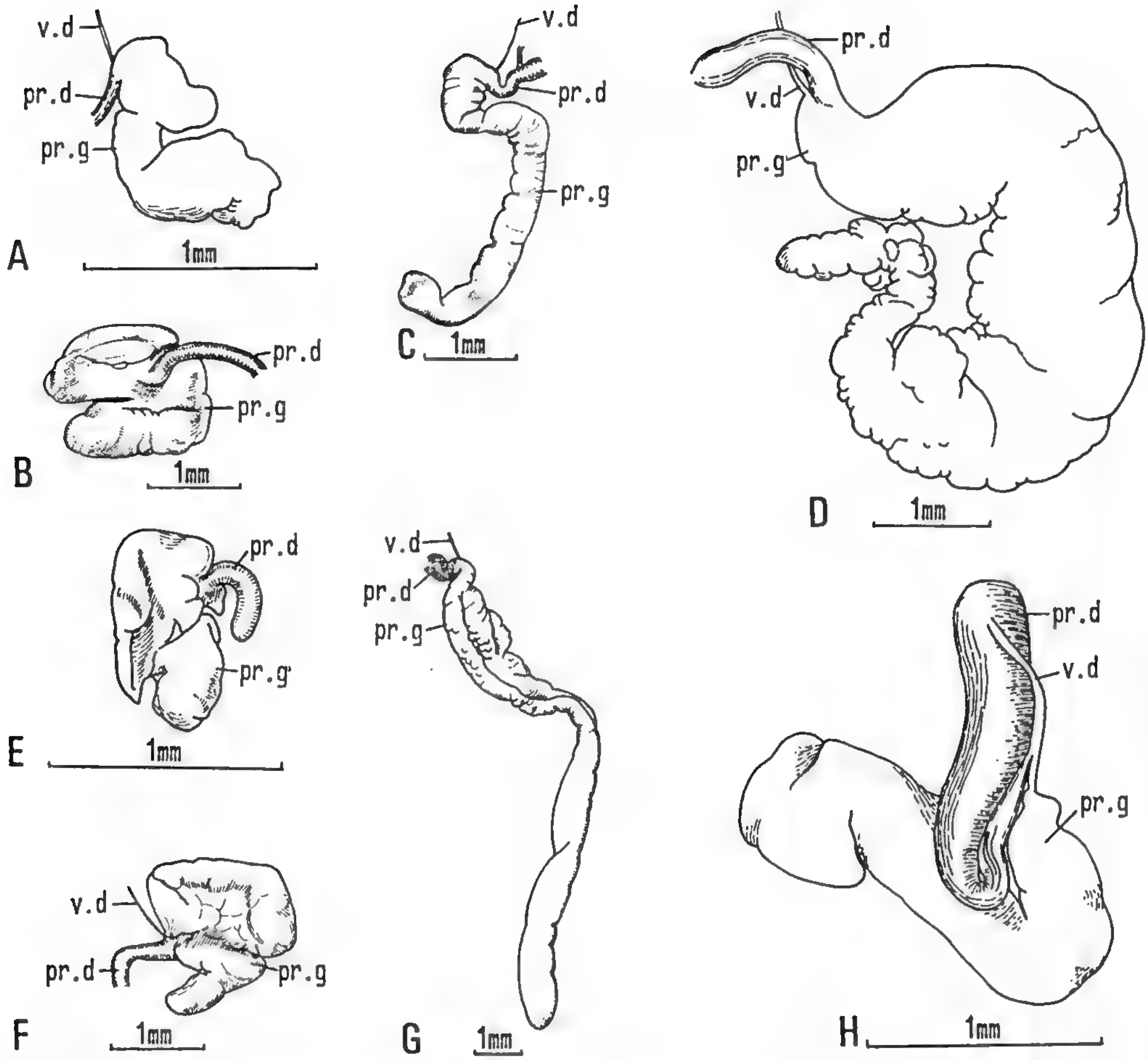

FIGURE 6. — Prostate glands (of holotypes or, F, paratype 1) of: A, *Pericryptodrilus nanus* (right). B, *Spenceriella* (*Austroscolex*) *hollowayi* (right). C, *Diporochaeta plutelloides* (left). D, *Eastoniella howeana* (right). E, *Spenceriella* (*Austroscolex*) *howeana* (left). F, *S.* (*A*). *saundersi* (right). G, *Eastoniella modesta* (right). H, *Plutellus hutchingsae* (right).

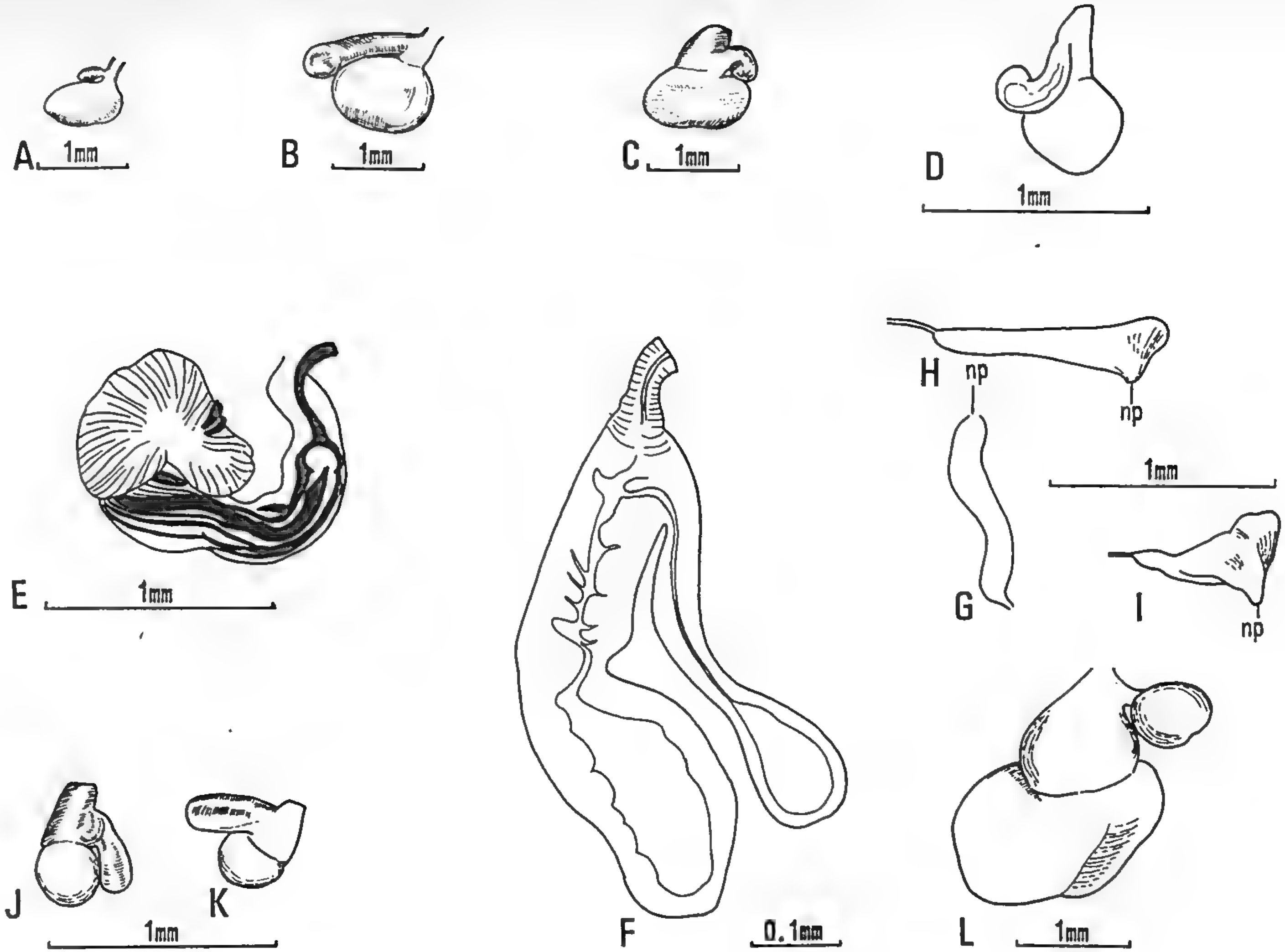

FIGURE 7. — A-D, Spermathecae (of holotypes or, B, paratype 1) of: A, *Diporochaeta plutelloides* (right IX). B, *Spenceriella (Austroscolex) saundersi* (left IX). C, *S. (A). hollowayi* (right IX). *D, S. (A). howeana* (left IX). E-I, *Plutelloides hutchingsae*, holotype, E, left calciferous gland of XII, F, spermatheca (right IX), G-I, nephridial bladders, G, of VI, H, of anterior intestinal region, I, of a caudal segment. J, K, Spermathecae of *Pericryptodrilus nanus*, holotype, J, right VIII, K, left IX. L, *Eastoniella howeana*, holotype, right spermatheca of IX.

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THE GENUS *LENOPHILA* (DIPTERA: PLATYSTOMATIDAE)

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SUMMARY

The relationships of the endemic Australian genus *Lenophila* Guérin (=*Celetor* Loew) are discussed, together with some details of the subfamily classification of the Platystomatidae. It is concluded that *Lenophila* is a rather isolated genus with some resemblance to the Scholastinae.

A key to the 6 species of *Lenophila* is given. *L. achilles, L. secta, L. danielsi,* and *L. nila* are described as new species.

Some notes are given on the biology of the species, including the apparent larval association with *Eucalyptus* in *L. dentipes* and the adult and larval association with *Xanthorrhoea* in other species.

The alimentary system and the internal reproductive systems of male and female are described.

INTRODUCTION

Lenophila is a small endemic Australian genus of flies belonging in the family Platystomatidae of the superfamily Tephritoidea. Representatives of this family were formerly included in the Otitidae (Ortalidae) but modern practice is to separate the two families rather widely within the superfamily (see Steyskal, 1961, McAlpine, 1973). The genus was until recently known as *Celetor,* but Munro (1959) has shown that *Lenophila* is the oldest available name.

Schiner (1868) erroneously recorded two species of *Lenophila* from New Zealand under the names *Lamprogaster strigipennis* and *Lamprogaster caerulea.* This mistake is based on wrongly labelled specimens of *L. dentipes, L. coerulea,* and *L. achilles* collected by the Novara expedition and still preserved in WM.

These flies have a strong superficial resemblance to certain true fruit-flies (family Tephritidae), particularly *Procecidochares, Ceratitella,* and other *Ceratitis*-like forms. This is due to similarity in body form (particularly the form of the female abdomen) and in wing markings. The deceptive resemblance caused Guérin-Méneville to give the inappropriate name *Lenophila,* which means fruit-loving. The species of *Lenophila* may be distinguished from these tephritids by the absence of a break in the costal wing vein where it joins the subcosta, by the absence of an acutely produced lobe to the anal cell (cell CuP) (though the cell itself may be acute at the posterodistal angle), and by the absence of incurved lower fronto-orbital bristles on the head. They may be distinguished from other Australian

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platystomatid genera by means of the key given by McAlpine (1973: 31-33), except for some individuals (particularly of *L. achilles*) which have no sternopleural bristle. These latter may be distinguished by the characteristic wing markings in combination with the angularly bent subcosta.

In listing material examined, we have abbreviated the names of the following collectors to the initials: G. Daniels, M. J. Fletcher, G. A. Holloway, D. K. McAlpine, D. P. Sands. The following abbreviations are used to indicate the collections housing material: AM, Australian Museum, Sydney; BM, British Museum (Natural History), London; ANIC, Australian National Insect Collection, C.S.I.R.O., Canberra; GD, collection of Mr. G. Daniels, Sydney; NMV, National Museum of Victoria, Melbourne; NSWDA, New South Wales Department of Agriculture, Rydalmere; OX, Hope Department of Entomology, University Museum, Oxford; PM, Muséum National d'Histoire Naturelle, Paris; UQ, Entomology Department, University of Queensland, Saint Lucia, Brisbane; USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.; WADA, Department of Agriculture of Western Australia, Perth; WAM, Western Australian Museum, Perth; WM, Naturhistorisches Museum, Vienna.

RELATIONSHIPS

McAlpine (1973) divided the family Platystomatidae into five subfamilies and placed *Lenophila* in the subfamily Scholastinae. The Scholastinae in general are distinguished by the following characters: closure of ptilinal suture valvate, the frontal lunule broad and more or less margined above; squama forming a large lobe behind wing base; subcosta curved forwards apically, not angular or curved outwards; aedeagus with distal complex, sclerotized glans, without pair of hollow terminal filaments; lateral arms of aedeagal apodeme (fultella) symmetrical, each connected to a lateral gibbosity of hypandrium and passing within the sclerotized genital ring (or *Gabelplatte*); sclerotized cap of sperm pump simply convex (not biconvex or bituberculate); tergite 5 much shorter than tergite 3, especially in ♀ where it is usually vestigial or absent; in ♀ tergite 6 absent (except in some *Pterogenia*); tergite 4 of ♀ often reduced; aculeus of ovipositor usually slender, with narrowly rounded apex. The most typical Scholastinae belong in the genera *Asyntona* Osten Sacken, *Mesoctenia* Enderlein, *Naupoda* Osten Sacken, *Neohemigaster* Malloch, *Pterogenia* Bigot, *Scholastes* Loew, *Trigonosoma* Gray, *Zygaenula* Doleschall, and perhaps also *Paryphodes* Speiser and *Pseudoscholastes* Frey.

Though sometimes included in the subfamily Platystomatinae, the Scholastinae are very sharply differentiated morphologically and are probably not more closely related to the Platystomatinae than to the Plastotephritinae. The Platystomatinae disagree with the Scholastinae in the following points: closure of ptilinal suture not valvate, its upper lip overlapping the lunule; aedeagus with simple oval or cylindrical glans and two (rarely three) hollow terminal filaments with the gonopores at their tips; left arm of aedeagal apodeme joined to and terminating in genital ring, right arm passing within genital ring to the usually unpaired right hypandrial gibbosity; sclerotized cap of sperm pump with 2 marked gibbosities or tubercules; tergite 5 always large in ♂, rarely reduced in ♀, tergite 6 generally present but small in ♀, tergite 4 of ♀ not reduced.

The following are the characters of the subfamily Plastotephritinae which, in general, distinguish them from the Scholastinae: closure of ptilinal suture not valvate; squama forming a linear fringe, without lobe; subcosta angularly bent forward distally; tergites 4 and 5 large in both sexes; tergite 6 generally present but small; aculeus of ovipositor variable, often broad and blade-like.

McAlpine (1973) indicated that the genus *Chaetorivellia* de Meijere is intermediate morphologically between the subfamilies Plastotephritinae and Scholastinae. We have now

seen an additional species of *Chaetorivellia* and a species which shows affinities both to *Chaetorivellia* and to the *Pterogenia-Neohemigaster* complex. One species of *Chaetorivellia* shows a complete tergite 5, fully as long as tergite 3, as well as an extremely short but sclerotized tergite 6, in the female, whilst another closely similar species has only a vestigial tergite 5. The males show no reduction of tergite 5. The squama of *Chaetorivellia* has a distinct lobe (unlike the Plastotephritinae) which is, however, much smaller than that of typical Scholastinae. The contour of the subcosta in *Chaetorivellia* is typical of the Scholastinae and unlike that of the Plastotephritinae which is angularly bent forward distally. The lips of the ptilinal fissure are not valvate (in the botanical sense of the term) but the upper (postfrontal) lip overlaps the lunule which is not visibly margined above. Although this condition contrasts with that of more typical scholastines, a study of several genera suggests that the valvate condition of the ptilinal suture is not one of the most clear-cut scholastine characters.

Though McAlpine previously regarded *Chaetorivellia* as agreeing more with the Plastotephritinae than any other subfamily, it is now felt that the balance of evidence indicates a relationship to *Pterogenia* and other genera of Scholastinae, despite the exceptionally plesiomorphic condition of the female postabdomen in one species.

Lenophila resembles *Chaetorivellia* in combining characters of the two subfamilies Plastotephritinae and Scholastinae, but the combination of characters is not identical. *Lenophila* females have tergites 5 and 6 much shortened, enclosing the spiracles. Tergite 4 may be well developed but shorter than tergite 3 (as in *L. dentipes*) or completely desclerotized (as in *L. nila*). The squama has a moderately developed lobe. The upper margin of the frontal lunule is covered by the anterior margin of the postfrons. The contour of the distal part of the subcosta is unlike that of any typical scholastine genus. It is bent forward somewhat angularly away from vein 1 and then curved distally instead of forwards. It therefore resembles the angular subcosta of the Plastotephritinae and to some extent that of the family Tephritidae.

There is evidence of independent reduction of the tergites of segments 4-6 in the females in several different platystomatid lineages, e.g. within the genus *Chaetorivellia*, within the genus *Euprosopia* Macquart, within the subfamily Angitulinae, and within the group of genera related to *Cleitamia* Macquart and *Euxestomoea* Hendel. Reduction of these tergites cannot be regarded as indicating relationship of *Lenophila* to the Scholastinae without supporting evidence. As this evidence is meagre, there must remain an element of doubt regarding the position of *Lenophila* in the Scholastinae. We consider it to be rather isolated phylogenetically from other living genera. The apparent dependence of *Lenophila* species on two plant genera, *Eucalyptus* and *Xanthorrhoea*, which are endemic to and highly characteristic of the Australian Region, suggests that the genus has evolved in this region over a long period of time.

INTERNAL ANATOMY

We have dissected adults of *L. coerulea* and *L. danielsi* and these have proved to be exceedingly similar anatomically. As almost nothing is known of the internal soft parts of this family a brief account of these is given.

The *alimentary system* is typical of the Schizophora with no obvious peculiarities. The two large elongate-ovoid salivary glands have a short common duct and long individual ducts of uniform thickness. The rather short oesophagus gives rise at its posterior end to a very long, straight duct terminating in the bilobed crop. The proventriculus has the usual shape of a depressed sphere and connects by a narrow constriction to the long, convoluted mid-gut which is thicker and somewhat sacculated anteriorly. There are 4 malpighian tubules joining together in pairs a very short distance from their junction with the

alimentary canal. The prerectal region of the hind-gut is much longer than in *Calliphora* Robineau-Desvoidy (Lowne 1895: pl. 24; Imms 1957: fig. 104) and almost as long as that of *Rhagoletis* Loew (Snodgrass 1935: fig. 198). The enlarged rectal sac has the usual 2 rectal papillae on each side.

In the *male reproductive system* (fig. 51) the elongate orange-coloured testes open into slightly shorter vasa efferentia. The vas deferens terminates anteriorly in a pair of sacs, the vasa efferentia opening close together into their terminal surface, the 2 accessory glands being joined more laterally within depressions in the sacs. There is a bend and a dorsal gibbosity at about the middle of the length of the vas deferens, which is looped round the rectum as in other Cyclorrhapha.

The *female reproductive system* (fig. 50) has a pair of spherical accessory glands on long fine ducts which are thickened and muscular distally. The three spermathecae are subspherical or slightly ovoid, the vesicles brownish orange, covered with a transparent cellular envelope. At the distal end the pigmented vesicle is deeply invaginated through the centre of the spermatheca apparently forming a plug (valve ?) in the basal orifice. No ventral receptacle or morula gland could be found.

Genus **Lenophila** Guérin

Lenophila Guérin-Méneville, 1843: 200. — Munro, 1959: 47-48. Type species *Ceratitis dentipes* Guerin = *Ortalis dentipes* Macquart.

Celetor Loew, 1873: 41. — Hendel, 1914a: 113-115; 1914b: 246. — Malloch, 1929: 505. Type species *Ortalis dentipes* Macquart = *Tephritis strigipennis* Macquart (Hendel, 1914a).

Hendel (1914a) has given a detailed generic description. As this is generally accurate it need only be noted here that some species have tergite 4 of female much reduced in size, instead of having the third and fourth tergites of equal length as indicated by Hendel.

The genus includes six species, all restricted to Australia. They have been found from the Townsville district in Queensland southwards to Victoria and westwards to the Adelaide district in South Australia. A species occurs also in south-western Australia, but the genus is unknown in the more arid parts of the continent. There are no records from Tasmania, apart from Verreaux's unreliably localised material. This may not necessarily indicate the absence of the genus from that state, as relatively little collecting has been done there, and both the known host-plant genera are present.

L. dentipes, though undoubtedly related to the other five species of the genus, has diverged in a number of characters and probably represents a sister group to the rest of the genus. We therefore divide the genus into two species-groups, one of which includes only *L. dentipes*. These species groups are distinguished as follows:—

L. dentipes group	*L. coerulea* group
Third antennal segment rounded distally.	Third antennal segment mucronate anterodistally.
Anal crossvein transverse, the posterodistal angle of anal cell therefore approximately a right angle.	Anal crossvein oblique, the posterodistal angle of anal cell therefore acute.
Wing without basal black band but with pattern of spots and streaks in basal region.	Wing with definite black basal band at level of humeral crossvein.

L. dentipes group	*L. coerulea* group
♂ hind trochanter enlarged, and hind femur much swollen near middle of anterior surface.	♂ hind trochanter normal, hind femur without swelling.
♀ tergite 4 more than half as long as tergite 3, shining black.	♀ tergite 4 variably developed but less than half as long as tergite 3 except in *L. achilles*, never shining black.
♂ sternite 2 unmodified.	♂ sternite 2 with tubercle or process.
♂ stipe of aedeagus not winged, without terminal process.	♂ stipe of aedeagus with winged margins, and one or two long, acuminate terminal processes.
♂ cerci very long, united only at bases.	♂ cerci shorter, united by a membrane for their whole length.

KEY TO SPECIES OF *LENOPHILA*

1. Third antennal segment rounded distally; posterodistal angle of anal cell not acute; wing without separate black band at level of humeral crossvein, but with complex pattern of streaks and spots in basal region .... *dentipes*

— Third antennal segment mucronate anterodistally; posterodistal angle of anal cell acute; wing with separate blackish basal band, which may be dissected by fine clear lines 2

2. Face tawny, with or without a dark median stripe; wing with preapical stripe well developed, extending into second posterior cell; metasternum with pair of processes in ♂, with 2 small tubercles in ♀ .... *achilles*

— Face creamy white with blackish median stripe; preapical stripe little developed, not reaching vein 4; metasternum unarmed 3

3. Basal dark band of wing dissected by fine clear lines .... *secta*

— Basal dark band entire, at most invaded by some pale brown lines 4

4. ♂♂ (readily distinguished) 5

— ♀♀ (abdominal characters difficult to see in some dried specimens) 7

5. Hind tibia broadly swollen at and before middle; hind tarsus with prominent basal ventral tubercle; apophysis of sternite 2 with 2 anteriorly inclined yellow tubercles; outer surstylus narrowly elongate, slightly expanded distally with short, incurved distal section .... *danielsi*

— Hind tibia not or very slightly swollen near middle; hind tarsus without prominent basal tubercle; apophysis of sternite 2 of different conformation; outer surstylus not very elongate 6

6. Hind tibia dorsally with preapical gibbosity bearing a dense row of strong bristles, and with a small terminal tubercle; apophysis of sternite 2 with 3 short tubercles, the anterior median one most prominent .... *nila*

— Hind tibia with longer dorsal bristles not on a gibbosity or tubercle, with a compact preapical dorsal tubercle bearing short setulae and a shallow dorsal groove from beyond this to apex; apophysis of sternite 2 with 2 prominent posteriorly inclined tubercles .... *coerulea*

7. Tergite 4 vestigial, not readily visible .... *nila*

— Tergite 4 well developed, but much smaller than tergite 3 8

8. Yellow dorsal stripe behind tergite 4 expanding on each side into a very large yellow area on pleural membrane which extends below tergite 3, and almost reaches sternites; tergite 4 almost as wide as segment 7; spiracle of segment 7 on dorsal side of lateral keel .... *coerulea*

— Yellow stripe behind tergite 4 not much expanding where it extends on to pleural membrane, and not approaching sternites, the area lying below tergite 3 entirely brown; tergite 4 much wider than segment 7; spiracle of segment 7 on ventral side of keel....................................... *danielsi*

Lenophila dentipes (Macquart)
Figs. 2, 8, 14, 15, 42-44, 48.

Ortalis dentipes Macquart, 1843: 210, pl. 28, figs. 5, 5a.

Tephritis strigipennis Macquart, 1851: 290-291, pl. 27, fig. 2.

Detailed synonymy as given by Munro (1959) except that the last preceding reference is wrongly given.

This species stands apart from the other five species structurally. As it is the only species of the *dentipes* species group, its distinctive characters are those tabulated above for this group. Hendel (1914b: 246-247) has given a good description which we supplement as follows:

COLORATION: occiput brown, lateral occipital region black; posterior slope of vertex with one large white spot just behind ocellar spot and a white triangularly shaped one on each side, the latter one very narrowly connected to white posterior orbital area.

ABDOMEN of ♂: sternite 2 without trace of apophysis. Outer surstylus spatulate, somewhat constricted before the rounded apical expansion; inner surstylus incurved with 2 unequal black terminal teeth; stipe of aedeagus slender, with very narrow membranous margins and two rather short terminal processes, one of which is finely acuminate; preglans almost as long as glans; cerci much longer than surstyli, free except at bases.

ABDOMEN of ♀: tergite 4 large, shining black, with spiracles in deep, narrow incisions in lateral margins; tergites 5 and 6 extremely abbreviated, transverse, with spiracles in their lateral extremities; segment 7 with spiracles situated on the lateral carinae, near anterior end.

DISTRIBUTION: New South Wales — coastal areas and Warrumbungle Range (Coonabarabran district); doubtfully Victoria and Tasmania.

TYPE MATERIAL: Port Jackson (Sydney) (holotype ♂ of *O. dentipes*, OX, examined by Froggatt (1909) and Munro (1959), not seen by authors); Australie (apparent syntypes of *T. strigipennis*, 2 ♂, No. $\frac{2}{47}$, PM, examined by an author), J. P. Verreaux. A further ♂ in PM, No. $\frac{4}{46}$ is given as "Tasmanie, Verreaux" in the register (probable erroneous locality) and is therefore probably not a type. Unfortunately the type of *O. dentipes* was not seen during a brief visit to Oxford, but its identity is not in doubt (see Munro, 1959).

OTHER MATERIAL EXAMINED: 4 mi. S of Taree, on animal dung, ii 1968 (1 ♀, AM), M. Long; Newcastle, no other data (1 ♂, UQ); Catherine Hill Bay, iv 1949 (7 ♂, 2 ♀, ANIC, 1 ♂, BM), T. G. Campbell and S. J. Paramonov; Blue Lagoon Reserve, near The Entrance, iii 1969

(13 ♂, 14 ♀, AM, 1 ♂ 1 ♀, NMV, 1 ♂ 1 ♀, SAM, 1♂ 1 ♀, USNM), G.A.H.; Woy Woy, sand bush, ix 1923 (1 ♂, AM), A. J. Nicholson; Mount White, near Gosford, iv 1949 (1 ♀, ANIC), S. J. Paramonov; Newport, near Sydney, i iv xi xii 1970-1971 (11 ♂, 11 ♀, AM, 1 ♂, 1 ♀, BM), D.P.S.; Narrabeen, near Sydney, no other data (1 ♂, UQ), x 1922 (1 ♀, AM), A. Musgrave; Lane Cove, near Sydney, i 1925 (1 ♂, AM), B. Bertram; Depot Beach, 10 mi. NE of Bateman's Bay, xii 1967 (1 ♀, ANIC), I.F.B. Common; Nelligen, iii-iv 1948 (1 ♀, ANIC), K. H. L. Key; 2 mi. E of Nelligen, xi 1949 (1 ♂, ANIC), Cane and Gemmell; Narooma, xii 1949 (2 ♀. ANIC), A. L. Dyce, v 1966 (1 ♂, NSWDA), anon.; Warrumbungle National Park, iv 1973 (11 ♂, 9 ♀, AM), M. S. Moulds and G.D.; Victoria, no other data (1 ♀, AM).

Lenophila achilles n. sp.
Figs. 7, 12, 21, 35-37, 47.

♂ ♀. COLORATION: head orange-fulvous; postfrons with black hairs except along orbital margins where hairs are yellow; ocellar spot and fronto-orbital plates black, but these black areas well separated; face concolorous with rest of head except for whitish pruinescence in antennal grooves, typically without but sometimes with median brown stripe, especially in specimens from Queensland. Posterior slope of vertex blackish with one white spot just behind ocellar spot, lateral part of slope and posterior orbital area white. Antenna, prelabrum, and palpus orange-fulvous. Thorax shining black with blue to green reflections; pleura with areas of light grey pruinescence distributed as in *L. danielsi*. Legs black, often narrowly tawny at apices of femora and bases and apices of tibiae; tarsi fulvous, slightly browned apically. Wing markings somewhat similar to those of *L. danielsi*; humeral black band enclosing some yellowish brown lines along veins; preapical band narrow but distinct, posteriorly crossing over vein 4 into second posterior cell, anteriorly fusing with large apical mark where it crosses vein 3. Haltere light brown basally, cream distally. ♂ abdomen with tergites black, largely pruinescent; tergites 2, 3, and 4 broadly margined with grey posteriorly; tergite 5 shining black; pleural membrane deep grey. ♀ abdomen with blackish tergites; tergite 2 margined posteriorly with grey; tergite 3 with yellowish brown pruinescence on each side which does not quite reach lateral margin; tergite 4 extensively brown-pruinescent; pleural membrane deep reddish brown, in life quite differently coloured from that of ♀♀ of *L. danielsi* or *L. coerulea*; a yellow transverse mark behind tergite 4, expanding below its lateral margins, in extent similar to that of *L. danielsi*.

HEAD: structurally similar to that of *L. danielsi*; height of cheek 0.17-0.22 of height of eye.

THORAX: generally as described for *L. danielsi*; metasternum of ♂ with pair of closely placed ventrally directed processes, pubescent on their posterior surfaces; metasternum of ♀ with pair of small tubercles only (metasternum of all other *Lenophila* species is unarmed in both sexes); sternopleural bristle variable, sometimes quite well developed, sometimes indistinguishable from surrounding hairs. Legs resembling those of *L. danielsi*; mid femur with a few anterior bristles near and just before middle in addition to numerous rather long posteroventral bristle-like hairs; hind tibia of ♂ (fig. 12) with very deep dorsal subapical incision, within which is a small tubercle bearing a fascicle of minute setulae; floor of incision otherwise membranous; on distal side of incision apex of tibia raised into a large dorsal tubercle; a broad gibbosity on proximal side of incision, which bears an anterodorsal comb of 11 or more very closely placed bristles, and which gradually tapers away towards the base; basal segment of tarsus slightly curved, a little excavated on anteroventral surface, slightly gibbous ventrally at base. Wing structurally similar to that of *L. danielsi*.

ABDOMEN of ♂: generally similar in structure to that of *L. danielsi*; apophysis of sternite 2 broad and low with pair of lateral tubercles, its anterior margin coinciding with the medially raised anterior margin of sternite; anterior margin of sternite 3 with raised

transverse ridge; main body of outer surstylus short and rather broad, narrowed basally, with anterodistal angle produced into a long medially directed process; inner surstylus much shorter than that of *L. danielsi*, with apical parts directed anteriorly, the translucent anterior tooth rounded, knob-like; aedeagus resembling that of *L. danielsi*, membranous wing of left side of stipe not expanded at distal extremity; tapering process at left side of distal end of stipe shorter than in *L. danielsi*, that on right side not distinguishable; cerci joined for their whole length, not emarginate distally.

ABDOMEN of ♀: somewhat similar structurally to that of *L. danielsi;* tergite 4 larger than in *L. danielsi* or *L. coerulea*, about 2/3 as long as tergite 3; tergite 5 almost completely desclerotized; spiracle 4 situated just within posterolateral margin of tergite 4; spiracle 7 situated on outer side of lateral carina of segment 7, towards its anterior extremity; pleural membrane with a single vertical series of black bristles below posterior margin of tergite 3 and another such series below posterior margin of tergite 4.

DIMENSIONS: total length, ♂ 4.3-7.0 mm, ♀ 4.4-6.1 mm; length of thorax, ♂ 1.9-2.6 mm, ♀ 2.1-2.7 mm; length of wing, ♂ 4.4-5.6 mm, ♀ 5.0-5.8 mm.

DISTRIBUTION: eastern Queensland and New South Wales; Victoria; south-eastern South Australia. Specimens in WM collected by the Novara Expedition are erroneously labelled "N. Seeland".

HOLOTYPE ♂: Royal National Park, near Sydney, 16 ii 1971 (AM), D.K.M.

OTHER MATERIAL EXAMINED: *New South Wales* — Grose Vale, near Kurrajong, i 1973 (paratypes, 2 ♂, 1 ♀, AM), G.D.; Vale Lookout, near Kurrajong, i 1973 (paratype ♀, AM), G.D.; Woy Woy, ii 1972 (paratype ♂, AM), D.P.S.; Pearl Beach, near Woy Woy, vii 1971 (paratypes, 6 ♂, 4 ♀, AM), M.J.F.; West Head, Ku-ring-gai Chase, near Sydney, i 1971 (paratypes, 8 ♂, 5 ♀, AM, 1 ♂, 1 ♀, BM, 1 ♂, 1 ♀, USNM), D.K.M.; Royal National Park, near Sydney, ii vii xi 1971 (paratypes, 6 ♂, 1 ♀, AM), D.K.M.; Currarong, near Jervis Bay, xi 1970 (paratypes, 3 ♂, 1 ♀, AM), G.D.; 2 km SSE of Nadgee Hut, Nadgee Nature Reserve, via Womboyn Lake, xi 1973 (10 ♂, 11 ♀, AM), G.A.H. and D. Lunney; Halfway Creek, 29 km S of Grafton, v 1972 (7 ♂, 2 ♀, AM), D.K.M.; Mount Wambelong, Warrumbungle Range, iv 1974 (1 ♂, 1 ♀, AM), G.D. *Australian Capital Territory* — Mount McDonald, near Cotter, iii xii 1973-1974 (11 ♂, 15 ♀, ANIC), M. Gill, Z.R. Liepa. *Queensland* — 8 km E of Paluma, Townsville district, i 1970 (1 ♂, AM), G.A.H.; Mount Archer, Rockhampton, vii 1974 (1 ♂, 1 ♀, G.D.); Noosa, ii 1957 (1 ♀, UQ), V. Wienert; Deception Bay, near Redcliffe, v xii 1971-1972 (8 ♂, 2 ♀, AM), D.K.M.; Brisbane, iv 1914 (1 ♀, UQ), H. Hacker; Bunya Mountains, iv 1972 (4 ♂, 2 ♀, AM), G.D. *Victoria* — Grampians, iv 1932 (1 ♂, 3 ♀, AM), A Musgrave; 8 km S of Lah Arum, Grampians, ii 1956 (2 ♀, ANIC), I. F. B. Common. *South Australia* — Mount Compass, S of Adelaide, x 1963 (2 ♂, ANIC), H. F. Lower.

Though clearly a member of the *coerulea* species group, *L. achilles* is sharply differentiated from other species of the group in facial coloration, the development of the preapical wing stripe, the armature of the male metasternum, and the relatively large tergite 4 of ♀.

The species is named after the Greek hero Achilles, the deep incision in the ♂ tibia recalling the proverbial weakness in his heel.

Lenophila secta n. sp.

Figs. 6, 11, 20, 32-34, 46

♂ ♀: very similar to *L. danielsi* in most characters and agreeing with the description given for that species except as indicated below.

COLORATION: distinction between median tawny zone of postfrons and white orbital margins less sharply defined than in *L. danielsi*, the line of contact between these zones tinged with brown. Posterior slope of vertex blackish with 3 densely pruinescent white spots as in *L. coerulea* but lateral spots triangularly shaped and isolated from the white posterior orbital area in both sexes. Wing hyaline, with basal black band divided by pattern of clear spots and streaks as shown in fig. 6; preapical band narrow and short, posteriorly not reaching to middle of first posterior cell. Haltere light brown basally, cream distally. ♂ abdominal tergites black; tergites 2, 3, and 4 broadly margined with grey posteriorly, anterior margins of tergites 3, 4, and 5 grey; sternites and pleural membrane dark greyish brown without any other coloured markings. ♀ abdominal tergites mostly black; posterior margin of tergite 2 and anterior margin of tergite 3 grey, tergite 4 brown with its posterior margin orange; pleural membrane and sternites coloured as in *L. danielsi*.

HEAD: structurally similar to that of *L. danielsi;* height of cheek 0.19-0.27 of height of eye.

HIND LEG of ♂: tibia not swollen near middle, with short, compact and ventrally directed anterodorsal comb of bristles placed approximately at distal sixth and another more distal anterior comb of bristles, the tips of which overlap apex as shown in fig. 11; no preapical dorsal tubercle; apical dorsal margin with a prominent lobe; hind tarsus without basal tubercle.

WING as in fig. 6; setulae as described for *L. danielsi.*

ABDOMEN of ♂: apophysis of sternite 2 narrow, short and low with ventrally directed pair of lateral tubercles, tubercles from lateral view triangular as in fig. 20; outer surstylus articulated at base, its main body broad, rounded, narrowed basally and more compact than in *L. danielsi*; anterodistal part slightly bilobed, anterior lobe elongate, directed inwards; posterior lobe broad and rounded; inner surstylus a little shorter than outer surstylus, almost straight, its length approximately 1/3 of height of epandrium with cercus, both terminal teeth directed distally, the posterior one continuous with main axis of inner surstylus. Aedeagus: stipe with broad, membranous wings along each lateral margin, not much expanded at distal extremity, with terminal tapering process on the left side shorter than in *L. danielsi* and minute process on the right side; a distinct preglans; glans complex in structure; cerci joined for their whole length, not emarginate distally.

ABDOMEN of ♀: with tergite 4 greatly reduced, apparently narrowly transverse; tergite 5 divided into 2 small black-haired, lateral sclerites; spiracle of segment 7 situated immediately above lateral carina.

DIMENSIONS: total length, ♂ 5.0-5.2 mm, ♀ 4.5-5.5 mm; length of thorax, ♂ 2.1-2.2 mm, ♀ 2.0-2.6 mm; length of wing, ♂ 4.3-4.6 mm, ♀ 4.1-5.3 mm.

DISTRIBUTION: eastern Queensland and New South Wales.

HOLOTYPE ♂: Deception Bay, Queensland, 6 xii 1971 (AM), D.K.M.

OTHER MATERIAL EXAMINED: *Queensland* — 2 miles W of Paluma, i 1970 (paratype, 1 ♀, AM), G.A.H.; Pistol Gap, near Byfield, i 1970 (paratypes, 1 ♂, 1 ♀, AM), G.A.H.; Mount Archer, Rockhampton, vii 1974 (paratype ♀, GD) G.D.; Watalgan Ra., near Bundaberg, vii 1971 (paratype, 1 ♀, ANIC), H. Frauca; Eidsvold, ix 1929 (paratype, 1 ♂, ANIC) anon.; NW Bluff Ra., upper slopes, Biggenden, i 1972 (paratype, 1 ♀, ANIC), H. Frauca; Noosa, viii 1959 (paratype, 1 ♀, UQ), F. A. Perkins; Brisbane, iv v 1914-1959 (paratypes, 1 ♂, 1 ♀, UQ), H. Hacker, R. Cullinane; Ballandean, near Stanthorpe, v 1925 (paratypes, 1 ♂, 1 ♀, ANIC), H. Jarvis. *New South Wales* — 3 miles SW of Broadwater, Myall Lakes, x 1956 (paratype, 1 ♂, ANIC), P. B. Carne; Gundamaian, Royal National Park, viii 1925 (paratype, 1 ♀, ANIC), I. M. Mackerras.

Lenophila danielsi n. sp.
Figs. 1, 5, 10, 17, 19, 28-31, 45, 49-51

♂♀. COLORATION: postfrons orange-tawny with black hairs; fronto-orbital plates and ocellar tubercle black with some grey pruinescence; the very broad orbital margin of postfrons and most of parafacial white with white hairs; face creamy white with blackish brown median stripe which reaches upper margin of prelabrum but does not quite reach antennal bases; anterior part of cheek tawny to yellowish brown; posterior part of cheek whitish; occiput dark grey, entire posterior slope of vertex with whitish pruinescence, the whole posterior orbit white. Antenna tawny, with dark brown arista. Prelabrum tawny to brownish in centre, densely white-pubescent at sides. Palpus fulvous. Thorax shining black, with blue or bluish green reflections; propleuron, upper posterior part of mesopleuron, hypopleuron, pleurotergite, and postnotum densely grey-pruinescent. Legs dark brown to almost black; tarsi fulvous, becoming brownish apically. Wing hyaline, with black markings as shown in fig. 5; humeral black band not enclosing definite clear lines; only the slightest indication of a preapical band arising from the large apical black mark in first posterior cell. Haltere light brown basally, cream on distal half. ♂ abdominal tergites black; tergites 2, 3, and 4 grey on posterior margins; sternites and pleural membrane dark greyish brown; pleural and intersegmental membranes without yellow markings. ♀ abdominal tergites mostly black; posterior margin of tergite 2 and almost all of tergite 4 grey, the latter often appearing partly yellowish in preserved specimens; tergite 3 black with uniform covering of brown pruinescence and thus scarcely shining even on posterior margin; pleural membrane dark greyish brown with a pale yellow area below tergite 4, which is restricted to upper half of membrane and does not noticeably extend below tergite 3, a pale, dull yellow transverse stripe behind tergite 4 connecting the yellow areas of each side.

HEAD: approximately as high as wide and 1.6 times as high as long; height of cheek 0.22-0.30 of height of eye; eye nearly twice as high as long; the following bristles present: two pairs of upper fronto-orbitals; inner and outer verticals; a pair of small divergent postverticals; cheek bristle. Antenna extending a little more than halfway from its basal insertion to centre of epistomal margin; segment 3 oval, with a small sharp anteriorly directed point near apex; arista minutely pubescent for its whole length. Palpus moderately broad.

THORAX: length of mesoscutum 0.86-0.88 of its width across notopleural calli; scutellum short, broadly rounded, very convex dorsally, with numerous hairs except on apical part; metasternum simple, without processes or tubercles; the following thoracic bristles present: humeral, 1 + 1 notopleurals (the right posterior notopleural duplicated in holotype), supra-alar, postalar, posterior intra-alar, 1 dorsocentral, prescutellar acrostichal, 3 pairs of marginal scutellars, strong mesopleural, a distinct but somewhat weaker sternopleural. Fore femur with some irregularly placed posterodorsal bristles on distal half, and a complete series of posteroventral bristles; mid femur without definite bristles but with some longer hairs on posteroventral surface; hind femur with a few dorsal bristles distally, in ♂ as long as tibia, in ♀ slightly shorter than tibia; ♂ hind leg with the following modifications (fig. 10): tibia broadly swollen near middle on dorsal surface, rapidly contracting beyond middle, with a small preapical anterodorsal tubercle, apical dorsal margin prominent, no anterodorsal comb, but a few irregularly placed short bristles on dorsal swelling; basal segment of tarsus somewhat curved, with a large basal ventral tubercle. Wing as in fig. 5; setulae on dorsal surface of vein 1 becoming sparser basally and not extending basad of junction with radial sector; vein 3 with irregularly placed dorsal and ventral setulae; other veins bare; posterodistal angle of anal cell strongly acute (but not produced into an acute lobe as in typical tephritids); squama small, more abbreviated than in *L. dentipes*.

ABDOMEN of ♂: tergites 3, 4, and 5 subequal in length; sternite 2 with forwardly directed apophysis, divided into a pair of apical tubercles by a shallow median cleft; protandrium without trace of tergite 6; sternite 6 (or 6+7) connected to the dorsal sternite 8 on left side; outer surstylus elongate, club-shaped, with relatively short, inwardly directed anterior lobe at apex, not articulated at base; inner surstylus almost as long as outer surstylus, almost straight except for forward curvature near apex, with 3 terminal black teeth of which the middle one is vertically elongate, and a prominent anterior translucent tooth; aedeagus: stipe with broad, membranous wings along each lateral margin, and at its distal extremity a very long tapering process on the left side and a minute curved process on the right side; a distinct partly sclerotized preglans; glans large and exceedingly complex in structure.

ABDOMEN of ♀: broadly ovoid; tergite 3 large, slightly shorter than compound tergite 1 + 2; tergite 4 less than half as long as tergite 3, but rather broad, considerably broader than segment 7; tergites 5 and 6 distinct but relatively short; sternite 2 without apophysis; segment 7 (ovipositor sheath) depressed, uniformly sclerotized, without distinguishable tergite and sternite but with sharp lateral margins, not much longer than broad; spiracles 1 and 2 in pleural membrane; spiracles 3 and 4 situated just within margins of tergites; spiracles 5 and 6 well within tergites; spiracle 7 situated immediately below lateral keel well in front of middle of segment.

DIMENSIONS: total length, ♂ 4.2-5.8 mm, ♀ 4.6-5.7 mm; length of thorax, ♂ 1.7-2.4 mm, ♀ 2.3-2.6 mm; length of wing, ♂ 3.7-5.0 mm, ♀ 4.8-5.6 mm.

DISTRIBUTION: coastal New South Wales.

HOLOTYPE ♂: Royal National Park, near Sydney, 19 xii 1970 (AM), D.K.M.

OTHER MATERIAL EXAMINED: 3 miles N of Dora Creek, near Lake Macquarie, i 1971 (paratypes, 2 ♂, 1 ♀, AM), D.K.M.; Ku-ring-gai Chase, near Sydney, xi 1970 (paratypes, 3 ♀, AM), G.D.; West Head, Ku-ring-gai Chase, i 1971 (paratypes, 2 ♀, AM), D.K.M.; Sydney, ii 1931 (paratypes, 2 ♀, AM), K. K. Spence, i 1919 (paratype ♂, UQ), G. H. Hardy; Royal National Park, ii iv xi xii 1970-1971 (paratypes, 26 ♂, 13 ♀, AM, 2 ♂, 1 ♀, BM), G.D., D.K.M.; Gundamaian, Royal National Park, i x 1926-1971 (paratypes, 3 ♂, 1 ♀, ANIC, 1 ♂, AM), I. M. Mackerras, G.D.; Goondera Ridge, near Heathcote, Royal National Park, xi 1970 (paratypes, 2 ♂, 3 ♀, AM), G.D.; Heathcote, xi 1970 (paratypes, 12 ♂, 7 ♀, AM, 2 ♂, 1 ♀, USNM, 1 ♂, 1 ♀, PM, 1 ♂, 1 ♀, MNM, 1 ♂, 1 ♀, CNC), D.K.M.; Currarong, near Jervis Bay, xi 1970 (paratypes, 7 ♂, 4 ♀, AM, 1 ♂, 1 ♀, NMV), G.D.; 5 miles S of Currarong, xi 1970 (paratype ♀, AM), G.D.

Lenophila coerulea (Macquart)

Figs. 3, 4, 9, 16, 18, 23-27

Tephritis coerulea Macquart, 1846: 212, pl. 18, fig. 15.

Trypeta Cluana Walker, 1849: 1019.

Lamprogaster caerulea. — Schiner, 1868: 285.

Celetor caerulea. — Loew, 1873: 41. — Hendel, 1914b: 247-248. — Malloch, 1929; 506.

Ortalis coerulea. — Froggatt, 1907: 308.

Lenophila caerulea. — Munro, 1959: 48-49.

Hendel has given a description which, though accurate, omits most of the characters distinguishing the species from closely related ones. This species agrees in most characters with the description here given for *L. danielsi,* but may be distinguished as given below.

COLORATION: posterior slope of vertex blackish with 3 densely pruinescent white spots, one in the middle, one on each side, the latter narrowly connected to white posterior orbit in ♂ but in ♀ the lateral spots smaller than those of ♂ and isolated from white posterior orbital area.

WING: rudiment of preapical black band usually more distinct than in *L. danielsi*, but not extending more than half way across first posterior cell.

HIND LEG of ♂: tibia not distinctly swollen near middle nor contracted beyond; preapical dorsal tubercle less close to apex than in *L. danielsi*; dorsal apical margin less prominent than in that species; an anterodorsal comb of bristles extending from just beyond middle almost to dorsal tubercle; tarsus without basal tubercle.

ABDOMEN of ♂: apophysis of sternite 2 prominent, erect, with pair of apical tubercles divergent and inclined posteriorly; sternite 3 with pair of transversely compressed tubercles joined by a transverse ridge. Outer surstylus articulated at base, its main body short and compact, bilobed distally, with posterior lobe short, broad, rounded, and anterior lobe elongate, directed inwards, more or less reaching median line. Stipe of aedeagus with terminal process of right side better developed than in *L. danielsi*, preglans shorter.

ABDOMEN of ♀: tergite 3 distinctly shining in median section, particularly near posterior margin where it is almost devoid of pruinescence; pleural membrane with very large very bright yellow area below tergite 4, extending below posterior part of tergite 3, and approaching but not reaching sternites, enclosing a pale orange spot below tergite 4, extending as a transverse stripe behind tergite 4 where it is more or less interrupted medially by a narrow pale brown area. Tergite 4 slightly narrower than segment 7; spiracles 3 and 4 in membrane very close to posterior angle of their tergites; spiracle 7 situated immediately above lateral keel.

DISTRIBUTION: eastern Queensland; coastal areas of New South Wales; Victoria. Collection dates for New South Wales include all months except April, May, and September.

TYPE MATERIAL EXAMINED: No label data, but Macquart (1846) gives "De l'Australie, Île Sidney" = Sydney (lectotype ♂ here designated of *T. coerulea* Macquart), not in good condition but characters of hind tibia and of wing pattern and head colour clearly visible, paralectotype ♂, paralectotype ♀, OX (Bigot collection); "Australasia ? Collector. One of Walker's series so named. E.A.W.", but Walker simply gives "New Holland" (lectotype ♂ here designated of *T. cluana* Walker, somewhat damaged but hind tibiae intact, BM), "Australia. Pres by the Ent. Club. B.M. 1844-12" (paralectotype ♀ of *T. cluana*, BM).

OTHER MATERIAL EXAMINED (localities only given): *Queensland* — Rockhampton (WM); Brisbane (UQ). *New South Wales* — 3 miles SW of Broadwater, Myall Lakes (ANIC); Cowan (AM); Ku-ring-gai Chase, near Sydney (AM); North Sydney (AM); Sydney (AM, NSWDA, UQ); Kurnell (NSWDA); Bundeena (AM, NSWDA); Royal National Park (AM, CSIRO); Heathcote (AM); Currarong, near Jervis Bay (AM); Nadgee Nature Reserve, via Wombоyn Lake (AM). *Victoria* — Gisborne (ANIC); "Victoria" (AM).

Lenophila nila n. sp.
Figs. 13, 22, 38-41

♂♀: very similar to *L. danielsi* in most characters and agreeing with the description given for that species except as indicated below.

COLORATION: posterior slope of vertex blackish with 3 thinly pruinescent narrow white streaks, lateral one broadly isolated from whitish posterior orbit, a brownish spot

surrounding suture on each side of vertex. Coloration of postfrons as described for *L. secta*. Wing with a distinct rounded black spot representing preapical stripe in anterior half of first posterior cell only. ♂ abdominal tergites black; tergite 2 pale grey-pruinescent on posterior margin; tergite 3 thinly grey-pruinescent on most of surface; tergite 4 grey-pruinescent on anterior margin and more narrowly so on posterior margin; tergite 5 narrowly grey-pruinescent on anterior margin. ♀ abdomen with tergites 1-3 coloured as in *L. danielsi*; tergite 4 yellow; pleural membrane brown anteriorly, entire pleural and intersegmental membrane of segment 4 and of lateral and ventral parts of segment 3 yellow, except for a black spot behind each posterior angle of tergite 3.

HIND LEG of ♂: tibia not swollen near middle, with a short, compact, dense anterodorsal comb of bristles centred approximately at distal fifth and placed on a slight elevation; apical dorsal margin prominent, a small pubescent dorsal tubercle placed right at margin; hind tarsus without basal tubercle.

ABDOMEN of ♂: apophysis of sternite 2 slightly inclined forwards, with 3 apical tubercles, the odd median one placed anteriorly to the others. Outer surstylus broad and more compact than in *L. danielsi*, not lobed, articulated at base; inner surstylus much shorter than outer surstylus, with one translucent and 2 black terminal teeth which are directed forwards; aedeagus very similar to that of *L. danielsi*, but with both preglans and glans shorter and more compact.

DIMENSIONS: total length, ♂ 3.9-5.5 mm, ♀ 3.6-5.0 mm; length of thorax, ♂ 1.5-2.3mm, ♀ 1.5-2.4 mm; length of wing, ♂ 3.7-4.8 mm, ♀ 3.3-4.9 mm.

DISTRIBUTION: south-western Australia; south-eastern South Australia; western Victoria.

HOLOTYPE ♂: Crystal Springs, 7 miles W of Walpole, Western Australia, 14 xii 1970 (AM), G.A.H. and H. Hughes.

OTHER MATERIAL EXAMINED: *Western Australia* — same data as holotype (paratypes, 4 ♂, 2 ♀, AM, 1 ♂, 1 ♀, BM); Swan River, no date (paratypes, 2 ♂, 4 ♀, WADA), L. J. Newman; John Forrest National Park, Darling Range, i 1971 (paratypes, 11 ♂, 6 ♀, AM, 2 ♂, 2 ♀, WAM), G.A.H. and H. Hughes; Hovea, i 1934 (paratype ♂, ANIC), K.R. Norris; Deep Dene, Karridale, i 1963 (paratype ♀, ANIC), L.M. O'Halloran; 10 miles S of Margaret River, xi 1958 (paratype ♂, ANIC), E.F. Riek; Bunbury, x 1958 (paratypes, 1 ♂, 1 ♀, AM), A. Snell; King George's Sound, no other data (paratypes, 1 ♂, 1 ♀, AM). *South Australia* — 4 miles W of Yumali, i 1959 (1 ♀, ANIC), L. J. Chinnick; Keith, iii 1964 (1 ♂, AM), G. L. Bush. *Victoria* — 5 miles S of Lah Arum, Grampian Mountains, ii 1956 (1 ♂, 2 ♀, ANIC, 1 ♂, AM), I. F. B. Common.

In the Bigot Collection, University Museum, Oxford, there is a specimen of this species labelled "*Urophora rufitarsis* Macq. ♂ ♀". It is above the cabinet label "U. Rufitarsis ♀. Am. Boreal. Macq". These circumstances would normally be indicative of type material, but reference to the description of *U. rufitarsis* Macquart (1855: 143-144, pl. 7, fig. 6) shows it to be an insect from Cape of Good Hope which is quite unlike *Lenophila*. *Herina rufitarsis* Macquart and *Lonchoea rufitarsis* Macquart are also quite different insects.

The specific name *nila* is based on a Sanskrit word for blue, but is here used as a Latin adjective with feminine inflection.

HABITS AND HABITAT

Lenophila dentipes apparently lives principally in *Eucalyptus* forests. Mr. Sands' material from his garden at Newport indicates that the species can survive under suburban conditions where considerable numbers of native trees have been retained. He informs us

that the adults are attracted to fresh possum faeces (apparently for feeding), and to the crushed leaves of the rutaceous plant *Zieria smithii* Andrews.

Mr. G. A. Holloway has previously provided notes on courtship and mating of *L. dentipes* (McAlpine, 1973), which he observed on the trunk of a smooth barked *Eucalyptus* at Blue Lagoon Reserve, near The Entrance. Courting pairs faced each other for some time but did not wave or display the wings. Mr. Holloway also observed apparent oviposition. On the shaded side of a *Eucalyptus* tree he found more than forty females of *L. dentipes* and *Euprosopia tenuicornis* which appeared to be laying eggs in the sap that was exuding from beetle damage under a piece of dead bark. On investigation he found dipterous larvae in the sap, but these may be *Cairnsimyia* (family Heleomyzidae) and not platystomatids.

At Warrumbungle National Park in late April Messrs. G. Daniels and M. S. Moulds found numerous adults of *L. dentipes* resting very near the ground on trunks of smooth-barked *Eucalyptus* trees; one of the flies was concealed under bark. Several of these were soft, newly emerged specimens, and it was particularly noted that no plants of *Xanthorrhoea* grew in the immediate vicinity.

From these observations of oviposition and newly emerged adults it appears that the larval stages of *L. dentipes* may be commonly associated with *Eucalyptus* species.

By contrast with the *dentipes* species group, where the only evidence of any plant association concerns *Eucalyptus* and possibly *Zieria*, adults of all species of the *coerulea* group are associated with plants of the genus *Xanthorrhoea* (family Xanthorrhoeaceae, formerly placed in Liliaceae or Juncaceae), and there is evidence that in at least three species, the larvae also live in this plant. *Xanthorrhoea* species are commonly known as grass-trees or black boys. Like *Lenophila*, *Xanthorrhoea* is restricted to Australia, and the family Xanthorrhoeaceae is restricted to Australia, New Guinea, and New Caledonia. Adults of species of the *coerulea* group are frequently found on leaves of *Xanthorrhoea*, a fact first noted by Froggatt (1907, as *Ortalis coerulea*), and this is probably the source of most collected material of the group. The recent statement by McAlpine (1973) that specimens had been taken on flowers of *Xanthorrhoea* is an error, the specimens referred to having been taken on the leaves. Our friends G. Daniels, G. A. Holloway, and R. Mulder confirm our recent observations that these flies are always found on the leaves and not on inflorescences. This is interesting as the flowers of *Xanthorrhoea* are insect-pollinated and produce a large quantity of nectar which attracts other Diptera and Hymenoptera. The following species of *Lenophila* have been collected on leaves of *Xanthorrhoea* species: *L. achilles* (Daniels, Fletcher, Holloway, Liepa, McAlpine); *L. secta* (McAlpine); *L. danielsi* (Daniels, Holloway, McAlpine); *L. coerulea* (Froggatt, Daniels, McAlpine); *L. nila* (Holloway and Hughes).

The systematics of the genus *Xanthorrhoea* have been dealt with by Lee (1966) who states: "These species, however, to some extent, fall short of the standards of discreteness generally required of a species, and there are strong field indications of hybridism". Furthermore, the specific characters are often to be found in the inflorescence and the flies are seldom found on plants bearing inflorescences. Lee provides no characters for the separation of *X. media* R. Brown and *X. resinosa* Persoon on vegetative parts. It is possible that the distribution of the different species of *Xanthorrhoea* is imperfectly known, even in the Sydney district. For these reasons we have been unable to identify the host species of *Lenophila* in many cases. In the Sydney district *X. arborea* R. Brown is a readily identified species common in sandy gullies, but repeated searching of this species has failed to produce any specimens of *Lenophila*, and it is assumed to be unattractive to the flies. *X. minor* R. Brown has been examined by G. A. Holloway at Nadgee Nature Reserve and no *Lenophila* adults were seen on it, though *L. coerulea* and *L. achilles* were present in a nearby stand of *X. australis* R. Brown in dry sclerophyll forest. *X. macronema* F. Mueller has been examined in only one locality but no *Lenophila* were found on it.

Lenophila achilles is, in our experience, found on tall, arborescent plants (height of trunk or caudex usually between 1 and 2½ m) with narrow leaves. They were taken on such plants at Royal National Park and West Head, near Sydney, at Halfway Creek, near Grafton, and at Deception Bay, near Brisbane. The plants at Halfway Creek and Deception Bay may be *X. australis* but, according to Lee (1966) and Beadle, Evans, and Carolin (1972) this species is unknown in coastal areas of the Sydney district. One of the tall plants later seen in flower at Royal National Park proved to be *X. resinosa* (though outside the size range given for this species by Lee). The flies have generally been taken in open sunny situations, but at West Head *L. achilles* was taken together with *L. coerulea* under semi-shaded conditions in *Eucalyptus* forest. *L. danielsi* was found only a short distance away (c. 100 m) in open heath-country on somewhat smaller plants (perhaps *X. resinosa*). At Deception Bay one specimen of *L. secta* was found together with the specimens of *L. achilles*. Mr. Daniels informs us that he obtained *L. achilles* at Grose Vale on leaves of *Xanthorrhoea* with tall trunks, growing under Eucalyptus trees near a dry stream bed.

Lenophila danielsi and *L. coerulea* have been commonly found on somewhat smaller plants of *Xanthorrhoea* than the above at several localities in Royal National Park and at other localities in coastal New South Wales. The plants are probably either *X. resinosa* Persoon (= hastile R. Brown) or *X. media* R. Brown, but we are unable to distinguish these two species when not in flower. The flies are generally seen on plants with trunks 20-80 cm high, especially those in prominent situations. However they are rarely found on plants with inflorescences, either flowering or fruiting, and none has been seen on the young *Xanthorrhoea* plants, which are often very numerous where the flies occur. *L. coerulea* and *L. danielsi* rest longitudinally aligned with the leaf, always with the head downwards. At rest the wings are flexed over the abdomen, their long axes parallel to one another and to that of abdomen, their posterior margins overlapping. While walking, the wings are spread forwards to form a very wide angle and then flexed back with a rowing motion. During this wing-waving, the two wings are usually flexed in unison, but may be moved alternately for shorter periods and with smaller amplitude. During warm weather in the heat of the day (temperature probably not above 30°C) individuals were seen to indulge in very rapid wing-flicking which was not observed at lower temperatures. Some specimens have been seen in copula on the leaves during the morning, but more rarely in the hotter part of warm days as very few females are on the leaves at such times. On one occasion (4 xii 1970 at Royal National Park) between 5.30 and 6.30 p.m. numerous pairs of *L. coerulea* were seen *in copula* on the leaves, always facing downwards with the wings fully flexed over abdomen. On 9 xi 1974 at West Head, Ku-ring-gai Chase, numerous copulating pairs of *L. coerulea* were again encountered shortly before sunset. These observations seem to indicate that the peak of mating activity in *L. coerulea* is reached in the late afternoon.

Aggregations of these flies on individual plants could be partly due to visual attraction to the larger and more prominent plants, but occasionally we have received impressions that other factors may influence aggregation. At Ku-ring-gai Chase near Terrey Hills in heath country on 15 vi 1974, approximately 9 examples of *L. coerulea* belonging to both sexes were seen simultaneously on one plant of *X. resinosa*. Although there were some hundreds of other *Xanthorrhoea* plants in the vicinity, many of them of similar appearance to this plant, no *Lenophila* could be found on them despite a wide search. This aggregation could not be accounted for simply by the appearance or location of the plant, nor by recent emergence from the plant as all were mature individuals. Factors in aggregation could be either unusual chemical properties of the favoured plant, or attraction of the flies to each other, either chemically or visually.

G. A. Holloway informs us that he found a number of specimens of *L. nila* on *Xanthorrhoea* leaves at Crystal Springs and John Forrest National Park, Western Australia. Most of the plants on which he found them at Crystal Springs were in flower. He also

supplies the following interesting notes made on 22 i 1971 at John Forrest National Park: "Adults of *Lenophila* (*nila*) were found only on the shaded side of smooth-barked *Eucalyptus* trunks, and not on rough-barked species, only up to a level of 120 cm from the ground. They were usually in a resting position facing either up or down, more often up. When approached with a small hand net, they turned to face the net, often moving the wings in a rowing action. The wing movement increased in frequency as the net approached the specimen. Nine males and seven females were captured between 4.30 and 5.00 p.m. Conditions were very hot, the temperature registered at 2.00 p.m. that day being 43°C." These observations are of special interest as the only available indications of the resting place for species of the *Lenophila coerulea* group when they are not on *Xanthorrhoea* leaves.

The very few cases of *coerulea* group adults reared from the immature stages indicate that they live in trunks of *Xanthorrhoea*.

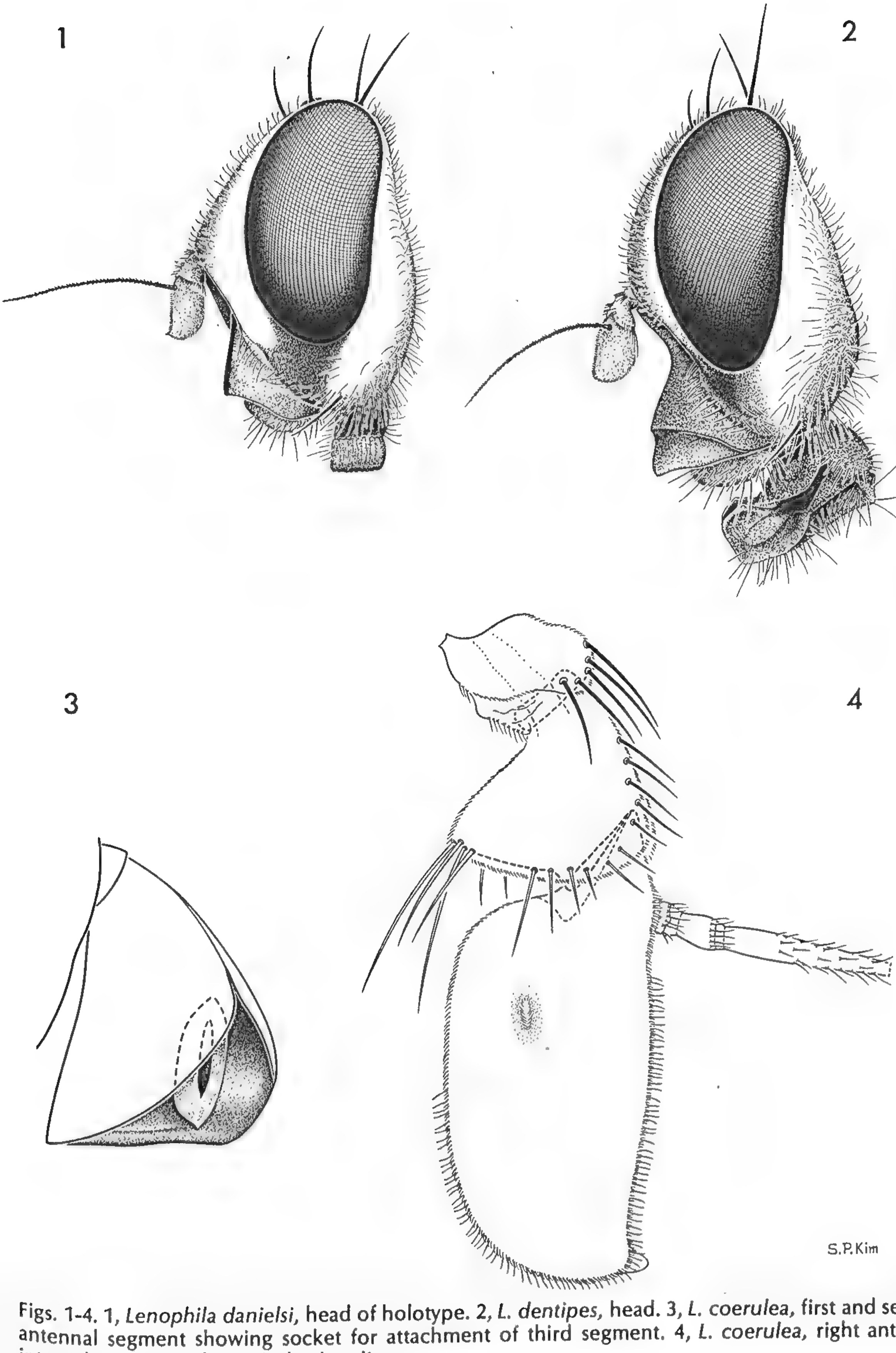
Froggatt (1896) refers to a "very pretty little fly" of "the family Trypetinae" which lives in the rotting caudex of *Xanthorrhoea* in the Sydney district. He reared several of these from the pupa, and stated that the adult "is often found upon the leaves, moving its wings up and down (as many members of this family do when resting), but is very hard to catch; common in November". He gives short descriptions of the pupa and adult. We do not think there is much room for doubt that these notes refer to a species of the *Lenophila coerulea* group, but his description of the adult is very inaccurate. Perhaps it is based on a few immature reared specimens in imperfect condition. None of Froggatt's early material can now be found, but in BM and NSWDA collections there are adults of "*Ortalis coerulea*" collected on leaves by Froggatt in 1902.

C. E. Chadwick and M. I. Nikitin collected four adults of *L. coerulea* on their laboratory window at Rydalmere, near Sydney, during the months of August and October, 1969. Mr. Chadwick has informed us that at this time he was keeping material of dead *Xanthorrhoea* trunks infested with the curculionid weevil *Trigonotarsus rugosus* Boisduval and collected at Bundeena in May 1969. He considers that this was almost certainly the source of the flies.

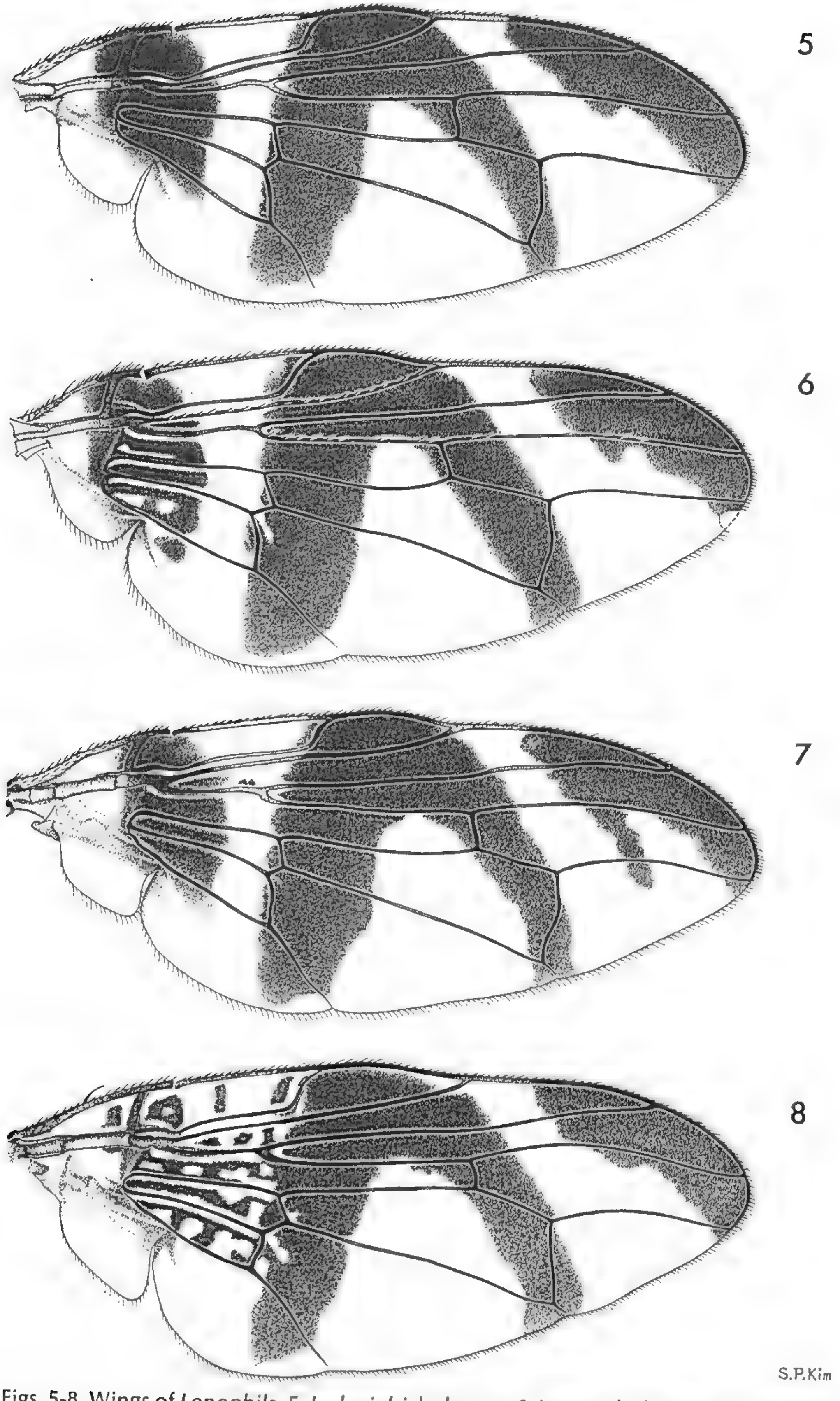
Two specimens of *Lenophila secta* in ANIC collection bear the following label data: "Ballandean (i.e. near Stanthorpe, Queensland), 21.5.25, Grasstree, H. Jarvis", and one of these also bears the label "Bred from rotting Grass-tree".

Miss Z. R. Liepa has sent us adults of *L. achilles* which she reared from larvae found by M. Gill among the leaf-bases of *X. australis* at Mount McDonald near Canberra. This presumably means that the larvae were in the outer part of the trunk, which is formed by the compacted leaf bases.

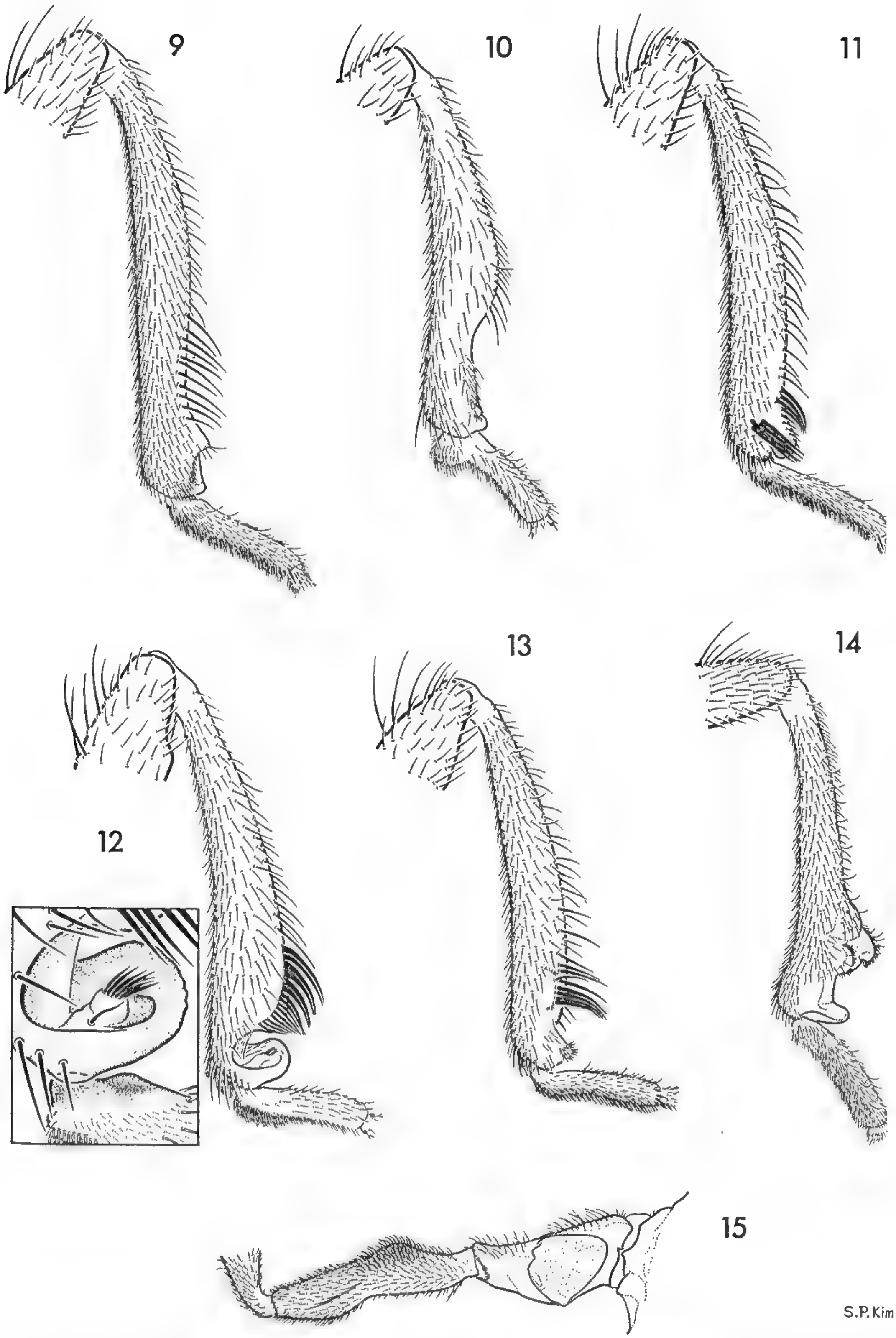
N. Scarlett informs us (*in litt.*) that he has reared *L. achilles* from larvae found in the rotting pith of *Xanthorrhoea australis* on the plateau area of the Brisbane Range, Victoria, on 2 ix 1967. Adults emerged on 14 i 1968. The plants were suffering from die-back due to *Phytophthora cinnamomi*, a fungal root parasite.



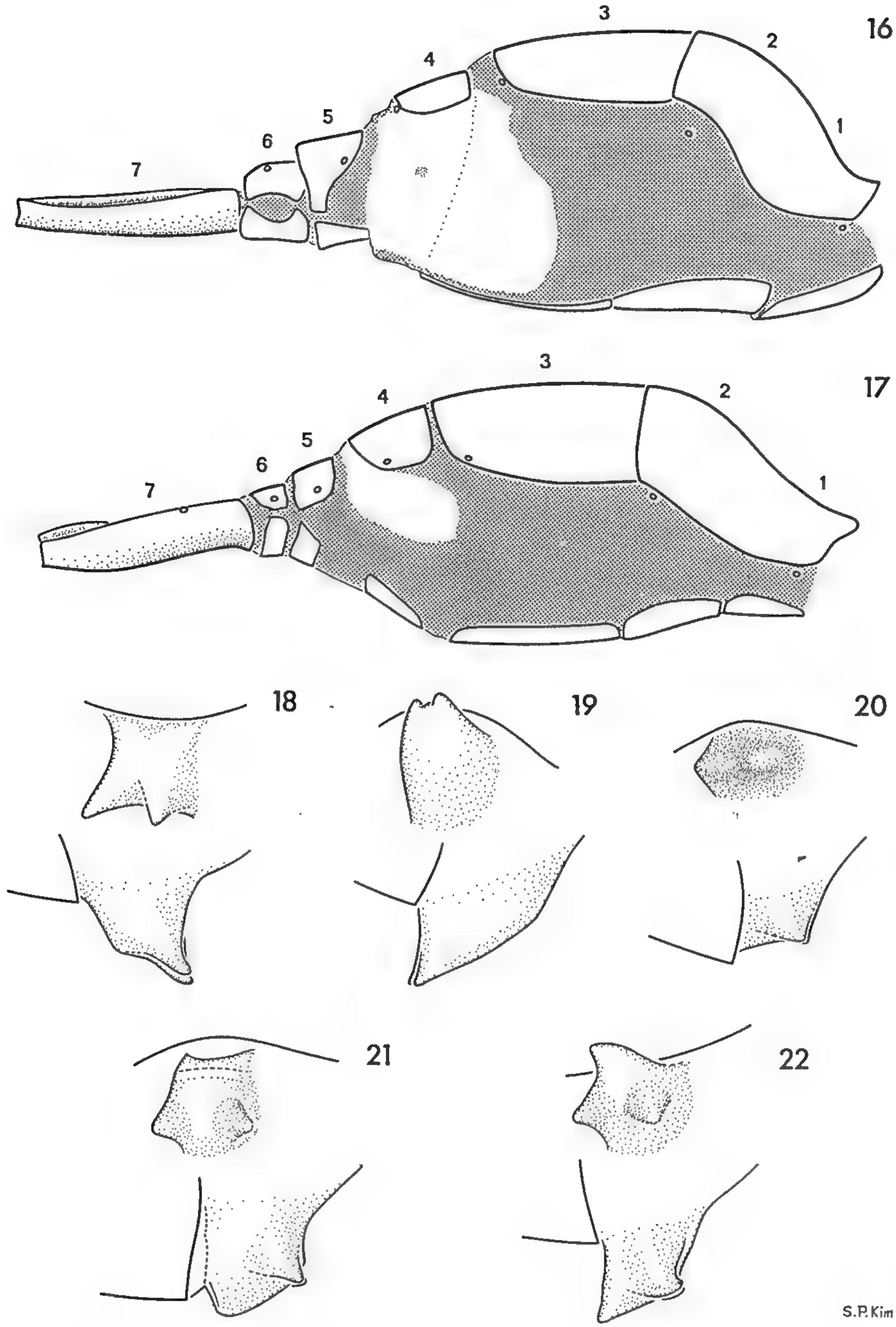
Figs. 1-4. 1, *Lenophila danielsi*, head of holotype. 2, *L. dentipes*, head. 3, *L. coerulea*, first and second antennal segment showing socket for attachment of third segment. 4, *L. coerulea*, right antenna, internal structures shown in broken lines.



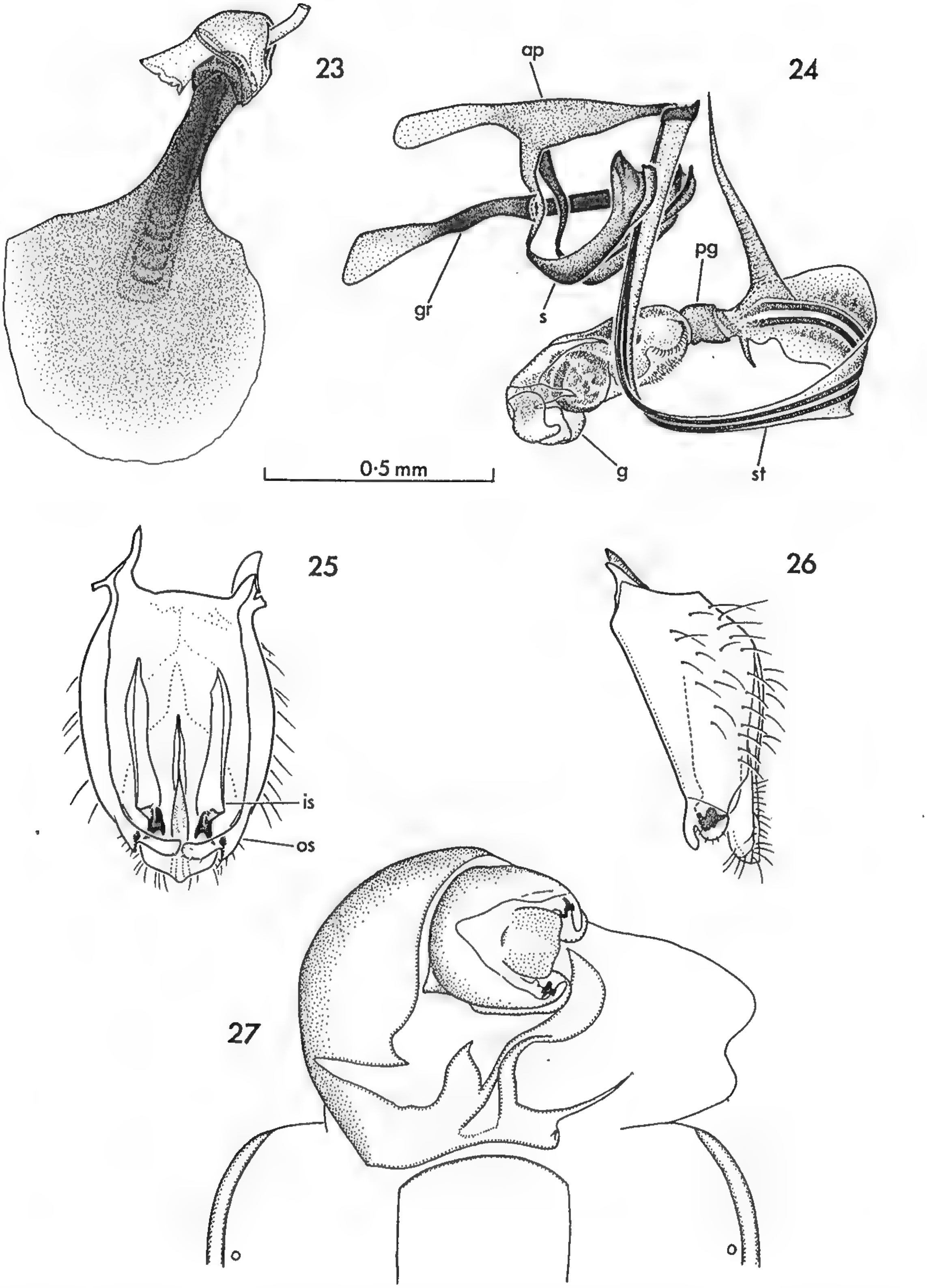
Figs. 5-8. Wings of *Lenophila*. 5, *L. danielsi*, holotype. 6, *L. secta*, holotype. 7, *L. achilles*, holotype. 8, *L. dentipes*.



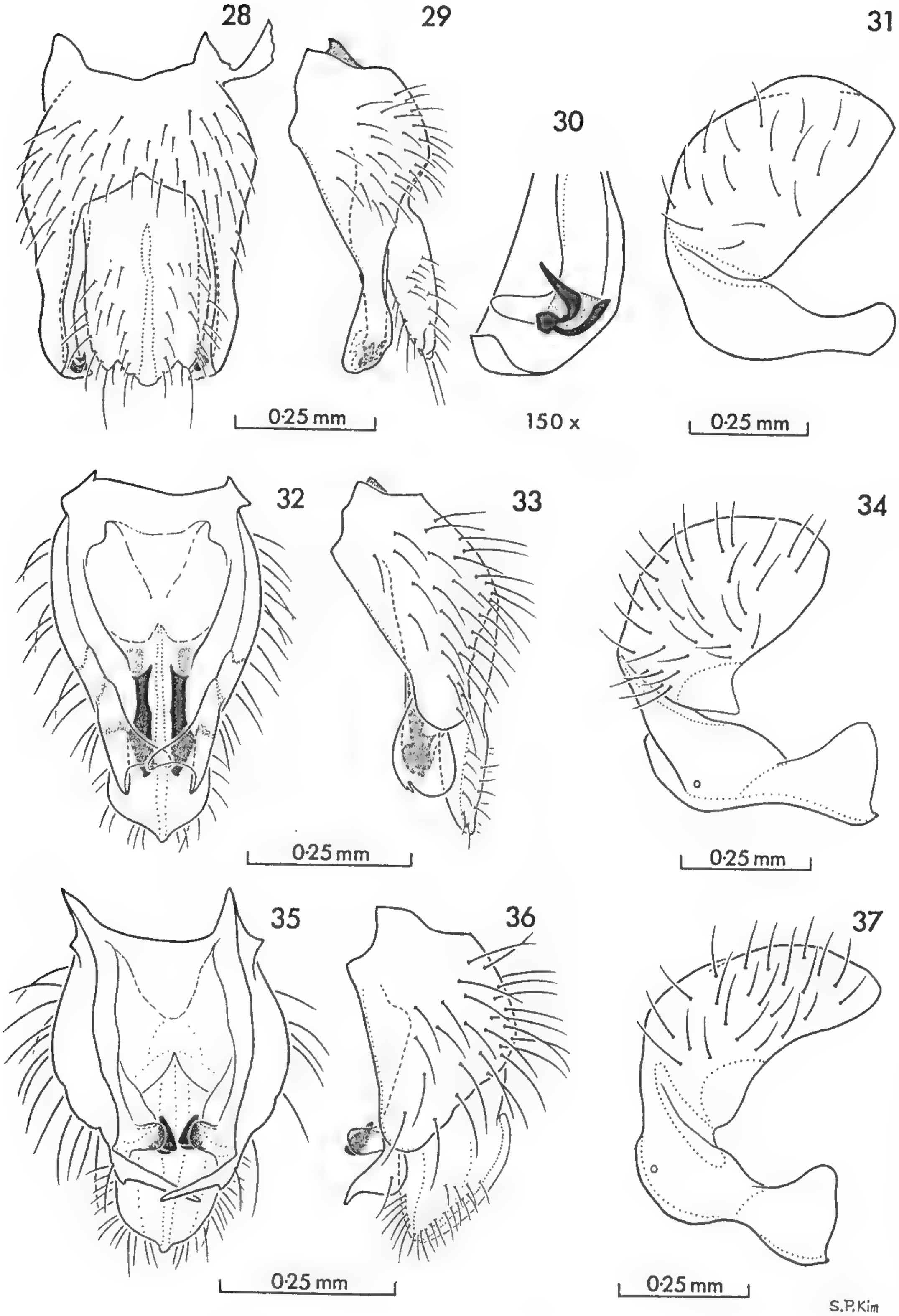
Figs. 9-15, left hind legs of male *Lenophila*. 9, *L. coerulea*, tibia and basitarsus. 10, *L. danielsi*, tibia and basitarsus of holotype. 11, *L. secta*, tibia and basitarsus of holotype. 12, *L. achilles*, tibia and basitarsus of holotype, inset detail of apex of tibia, X 400. 13, *L. nila*, tibia and basitarsus of holotype. 14, *L. dentipes*, tibia and basitarsus. 15, *L. dentipes*, coxa, trochanter, and femur from above.



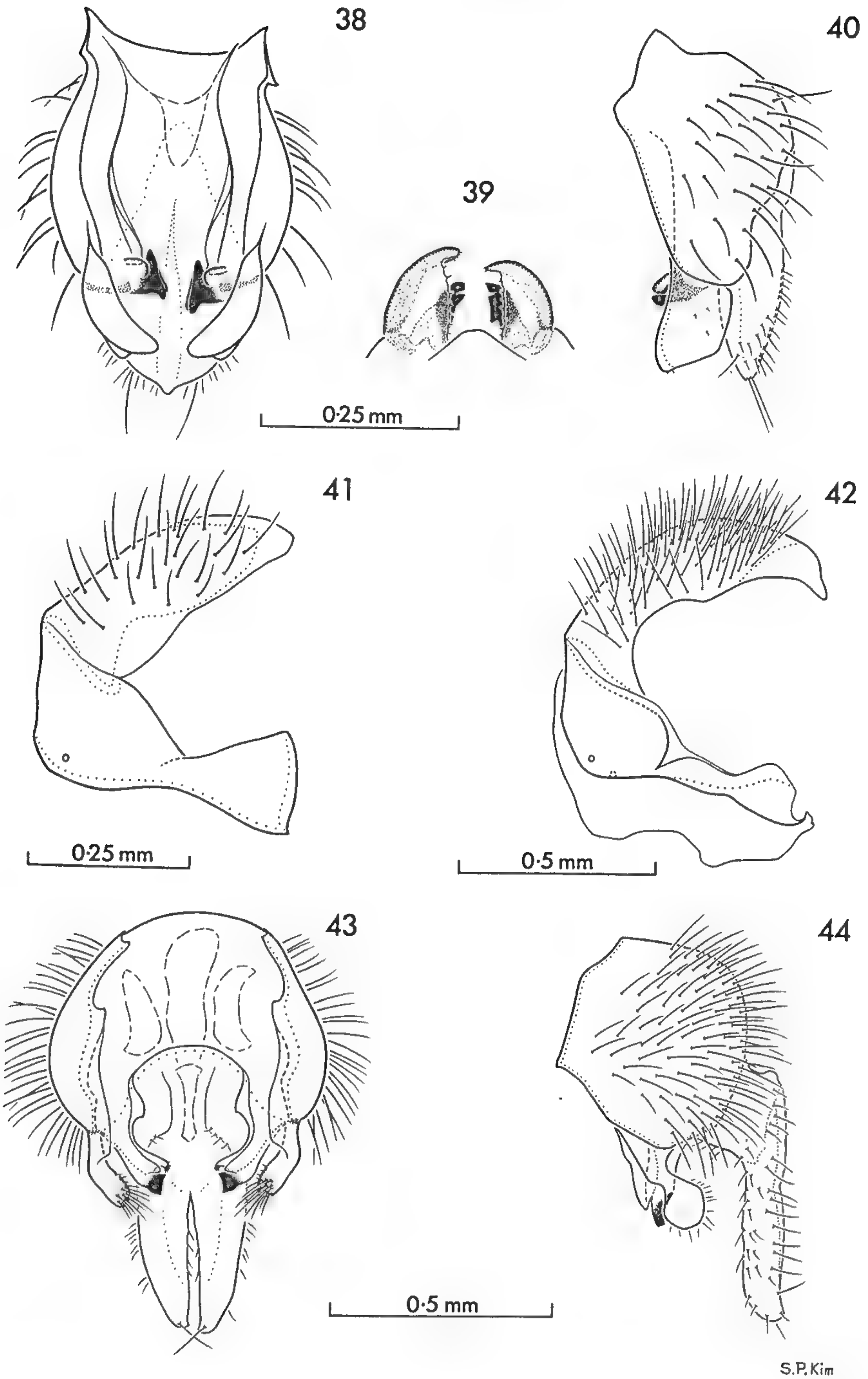
Figs. 16-22. 16, *Lenophila coerulea,* abdomen of female drawn from fresh material. 17, *L. danielsi,* the same. 18-22, processes of male sternite 2, ventral oblique view and left lateral view of each. 18, *L. coerulea.* 19, *L. danielsi.* 20, *L. secta.* 21, *L. achilles.* 22, *L. nila.*



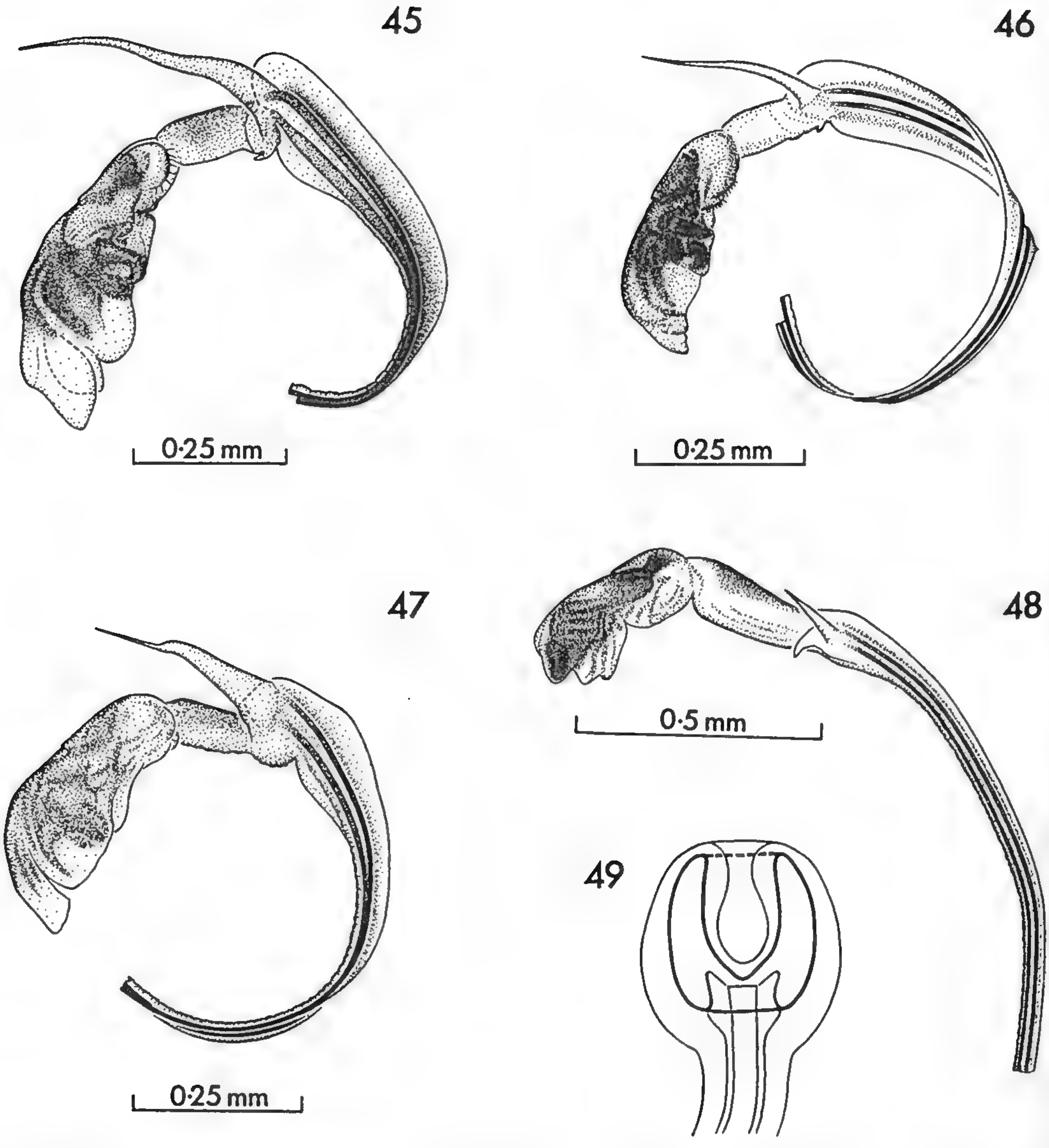
Figs. 23-27, *Lenophila coerulea*, male genitalia and associated parts. 23, sperm pump from left side, muscular parts removed. 24, aedeagus and associated basal structures from left, left arm of genital ring cut away. 25, epandrium from in front. 26, epandrium from left side. 27, postabdomen, ventral aspect. ap, aedeagal apodeme. g, glans of aedeagus. gr, genital ring. is, inner surstylus. os, outer surstylus. pg, preglans, lateral sclerites of sternite 9. st, stipe of aedeagus.



Figs. 28-37. Male postabdominal structures of *Lenophila*. *L. danielsi:* 28, epandrium from behind; 29, epandrium from left side; 30, detail of apices of right surstyli, medial view; 31, sclerites of protandrium. *L. secta:* 32, epandrium from in front; 33, epandrium from left side; 34, sclerites of protandrium. *L. achilles:* 35, epandrium from in front; 36, epandrium from left side; 37, sclerites of protandrium.



Figs. 38-44. Male postabdominal structures of *Lenophila*. *L. nila*: 38, epandrium from in front; 39, apices of surstyli from below; 40, epandrium from left side; 41, sclerites of protandrium. *L. dentipes*: 42, sclerites of protandrium; 43, epandrium from in front; 44, epandrium from left side.



Figs. 45-49. Aedeagi of *Lenophila*. 45, *L. danielsi*. 46, *L. secta*. 47, *L. achilles*. 48, *L. dentipes*. 49, spermatheca of *L. danielsi*.

50

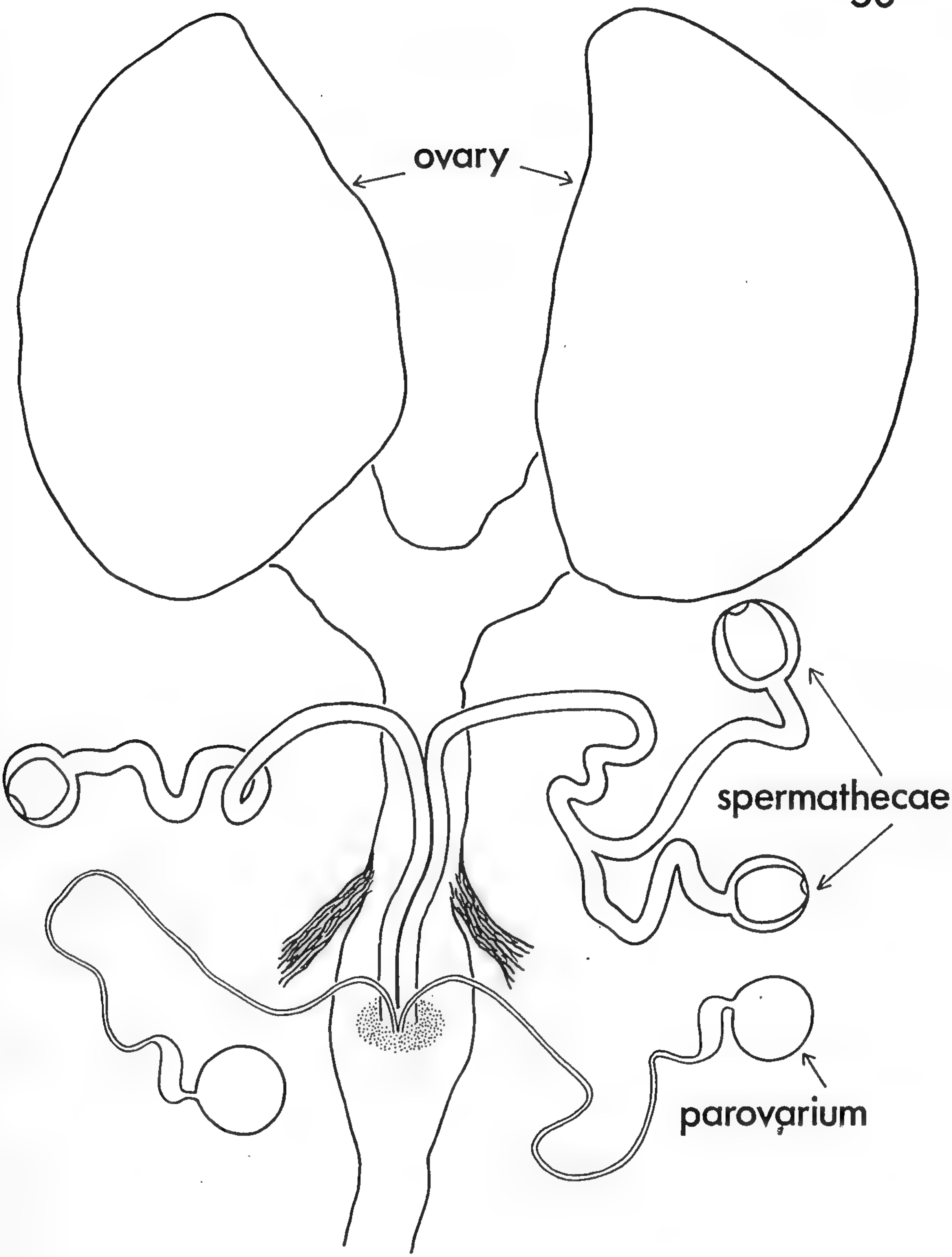


Fig. 50. *Lenophila danielsi,* female reproductive system.

51

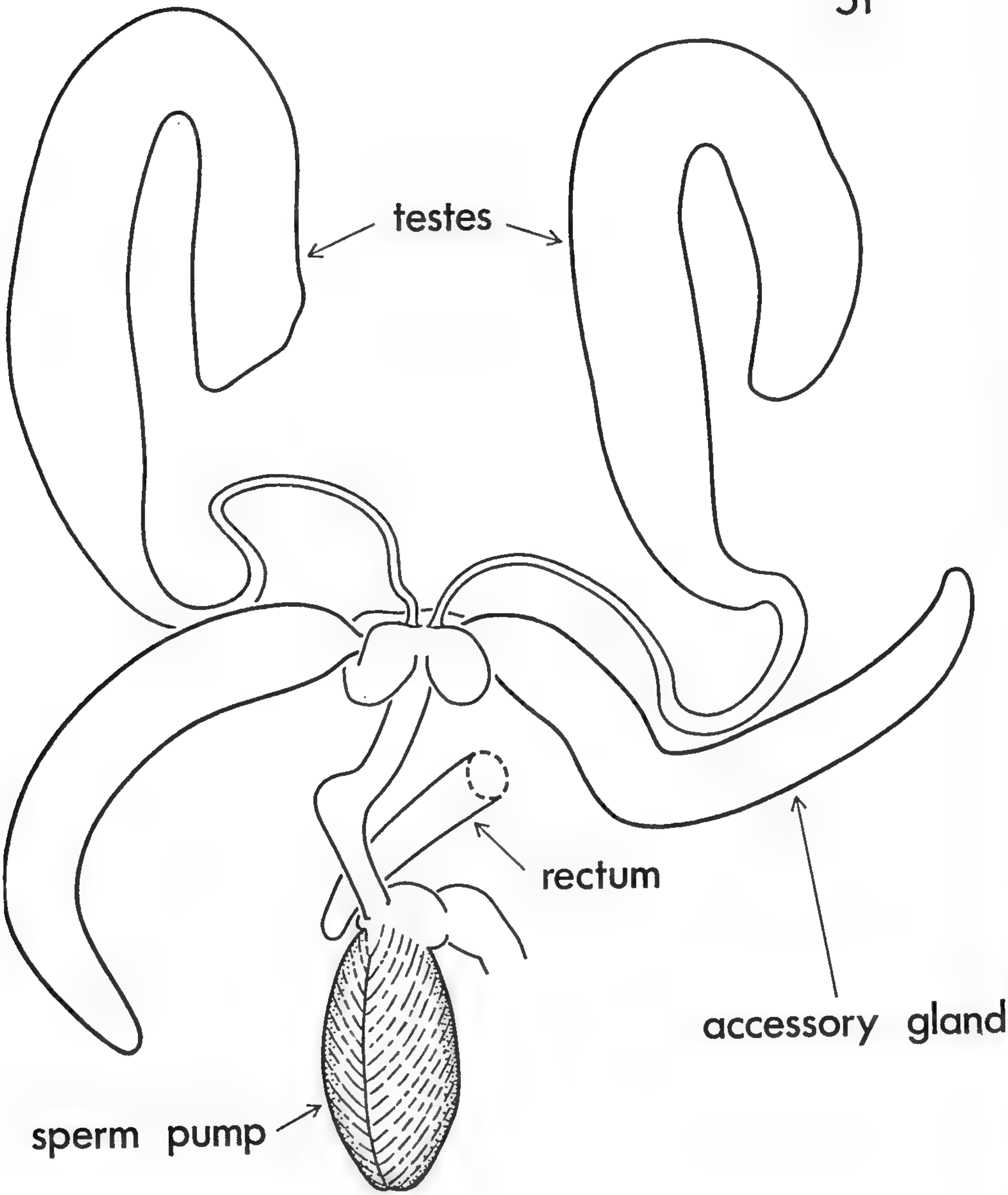


Fig. 51. *L. danielsi,* male reproductive system.

ACKNOWLEDGEMENTS

Our thanks are due to Mr. G. Daniels, Mr. G. A. Holloway, Mr. M. Fletcher, Mr. D. P. Sands, and Mr. N. Scarlett for collecting much material for this study and for supplying field notes. We are indebted to Mr. C. E. Chadwick (Biological and Chemical Research Institute, New South Wales Department of Agriculture), Dr. D. H. Colless and Miss Z. R. Liepa (Commonwealth Scientific and Industrial Research Organisation, Australian National Insect Collection), Mr. G. B. Monteith (Entomology Department, University of Queensland), Mr. K. T. Richards (Department of Agriculture of Western Australia) for loan of material. We are indebted also to the following for access to types and other material under their care: Mr. E. Taylor and Mr. M. Ackland (Hope Department of Entomology, Oxford), Mr. B. H. Cogan (British Museum (Natural History)), Dr. L. Matile (Muséum National d'Histoire Naturelle, Paris), Dr. Ruth Lichtenberg (Naturhistorisches Museum, Vienna). This work has been aided by generous grants from the Australian Research Grants Committee and from the C.S.I.R.O. Science and Industry Endowment Fund.

POSTSCRIPT. The statement of Lower (1970. *Rec. South Aust. Mus.* 16(2):50) that *C. caerulea* is the type of *Celetor* by original designation is incorrect as Loew indicated no type species.

G. Daniels recently collected *L. dentipes* at Byfield State Forest, Yeppoon district, Queensland, significantly extending the known distribution.

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A CATALOGUE OF ECHINODERM TYPE-SPECIMENS IN THE AUSTRALIAN MUSEUM, SYDNEY

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SUMMARY

Over 1000 type-specimens representing 253 nominal species of echinoderms from all five classes are listed. The majority of species have been described by H. L. Clark (1909, 1916, 1938) and are from Australian waters. However, 61 species are from Antarctic waters, these having been described by Koehler (1920-1926). Two species of asteroid, *Ophidiaster propinquus* Livingstone and *O. watsoni* Livingstone are considered to be synonyms of *Linckia laevigata* (Linnaeus) and *Gomophia aegyptiaca* Gray, respectively. The ophiuroid subspecies *Ophiothrix stelligera atra* H. L. Clark, as represented by two paratypes in the present collection, is considered a synonym of *O. ciliaris rugosa* Koehler. *Ophiocoma alternans* Endean, a homonym, is given a new name.

INTRODUCTION

Late in 1971 D.L.P. compiled, in draft form, a catalogue of the type-specimens housed in The Australian Museum. Later (1974) the draft was handed over to F.W.E.R. for up-dating and completion. It was not until this time that the significance of a collection of echinoderms from Antarctic waters collected during the Australasian Antarctic Expedition (1911-1914), named by Koehler (1920, 1922 and 1926) and A. H. Clark (1937) and donated to the Museum in 1921 and 1931 respectively, was realised and the species added to this catalogue.

The echinoderm type-collection presently comprises about 1007 specimens, representing 253 nominal species. Of the species represented, 171 were collected around the coast of Australia or Lord Howe Island, 61 were collected in the Antarctic region and 21 were collected from various other Pacific localities. However, the collections include types of only about 17% of the known Australian fauna. This seemingly low figure reflects the fact that many of the Australian species are common to wide areas of the Indo-Pacific, and type-material of most of these species have a different area of origin.

It is unfortunate that about 170 Antarctic specimens were destroyed in July, 1939. A covering note in the Museum's Accessions Register at the time states that the "glass cell

container(s) (were) unknowingly cracked and the spems. found useless July 1939". The importance of these specimens as types was obviously not realised then. As a result the type-specimens of at least one species (*Anasterias* (=*Lysasterias*) *adeliae* Koehler) have now been lost. Of the remaining 168 or so missing specimens 140 apparently belong to the species *Ophioceres incipiens* Koehler, but it is impossible to account for the high number of specimens recorded for this species (see note on p. 352).

Many recent species of Australian echinoderms were described by Hubert Lyman Clark, who spent his professional career at the Museum of Comparative Zoology (M.C.Z.), Harvard University, U.S.A. He described the echinoderms collected by the "Thetis" and "Endeavour" (H.L. Clark, 1909, 1916 respectively), and paratypes and syntypes of some of these species are to be found in the M.C.Z. (Downey, 1968, 1969; Dr. D. Opresko, 1974, M.C.Z,, pers. comm.) Later, following two expeditions to Australia in 1929 and 1932, H. L. Clark published his two great works (1938, 1946) on the Australian echinoderms; these remain the standard Australian reference works on this group of animals.

Entries in this catalogue are arranged alphabetically by original species name in each class. Where the genus- or species-name has changed subsequently, the new name is also given, together with a reference to the source of the change. A few type-specimens have been used in exchange with specimens of other species from other institutions. Where this has occurred and where some other specimens are unaccountably missing, the entry is italicized and the fact is noted in the text. Australian Museum catalogue numbers may be prefaced by the letters "E", "G" or "J".

LIST OF SPECIES

CRINOIDEA

cratera, Comatula H. L. Clark (1916, p. 12, pl. 2, fig. 1).
E6302, holotype, 8 miles east of Sandon Bluffs, New South Wales, 63-72 m.
E1631, 4 paratypes, locality same as E6302.
J2227-J2230, 4 paratypes, locality same as E6302. (4 paratypes in M.C.Z.)
Note: H. L. Clark (1916) records 14 specimens, one has not been found.

cyaneus, Metacrinus H. L. Clark (1916, p. 9, pl. 1).
E4689, holotype (part — stalk), eastern slope, Bass Strait, about 360 m.
E4690, holotype (part — calyx), locality same as E4689.
E2272, 2 paratypes, 20½ miles south, 19° east of Cape Everard, Victoria, 162 m. (broken and mixed with J2353, so specimens inseparable.)
J2353, paratype, south-east of Wilson's Promontory, Victoria (see E2272).
J2351, paratype, locality same as J2353. (3 paratypes in M.C.Z.)

dasybrachia, Cosmiometra H. L. Clark (1916, p. 24, pl. 4, fig. 2).
E4746, holotype, east of Flinders Island, Bass Strait, Tasmania, 126-180 m. (1 paratype in M.C.Z.)

diadema, Colobometra A. H. Clark (1910, p. 7).
J2770, holotype, Ugi, Solomon Islands.

mawsoni, Florometra A. H. Clark (1937, p. 10).
J5569, syntype, Adelie Land, 66°55'S, 145°21'E, 572 m, ooze, December 28, 1913.
Note: Clark (p. 13) notes "This species is described from one of the two specimens from Station 2; the other is similar to the one described." It is here assumed that Clark intended the two specimens to be regarded as syntypes. However, only one specimen, from Station 2 can be accounted for in this Museum's collections.

nomima, Monilimetra H. L. Clark (1938, p. 48, figs. 5 and 6).
J6274, paratype, False Cape Bossutt, near Broome, Western Australia, 1929.
=*Toxometra nomima* (Clark) — see A. H. Clark and A. M. Clark, 1967, p. 53.

paedophora, Himerometra H. L. Clark (1909, p. 524, pl. 47, figs. 4-10).
J840, holotype, off Manning River, New South Wales, 39 m, fine grey sand.
J831, 7 paratypes, locality same as J840.
=*Aporometra paedophora* (Clark) — see H. L. Clark, 1938, p. 42. (6 paratypes listed in the M.C.Z. catalogue cannot be found in the collection; Dr. D. Opresko, pers. comm.)
Note: Twenty-three specimens were recorded by H. L. Clark (1909) but only 14 can be accounted for, though of those the 6 in the M.C.Z. are apparently missing.

pericalles, Oreometra H. L. Clark (1916, p. 20, pl. 3, fig. 1).
E6300, holotype, 13 miles north by west of Double Island Point, Queensland, 45-47 m.
=*Reometra mariae* (A. H. Clark) — see A. H. Clark, 1947, p. 368.

perplexum, Comanthus H. L. Clark (1916, p. 14, pl. 3, fig. 2).
E6298, holotype, 11 miles south by east of Ballina, New South Wales, 48-51 m.
=*Comantheria perplexum* (Clark) — see A. H. Clark, 1931, p. 506 .

plectrophorum, Comanthus H. L. Clark (1916, p. 15, pl. 4, fig. 1).
E4702, holotype, east of Flinders Island, Bass Strait, 180-540 m.
=*C. (Cenolia) plectrophorum* (Clark) — see A. H. Clark 1931, p. 530. (1 paratype in M.C.Z.)

spanoschistum, Comanthus H. L. Clark (1916, p. 17, pl. 4, fig. 3).
E6299, holotype, east of Babel Island, Bass Strait, 108-126 m.
E4744, paratype, east of Flinders Island, Bass Strait, 126-180 m.
E4745, paratype, locality same as E4744.
E4751, 3 paratypes, east of Babel Island, Bass Strait, 90-144 m.
E5033, 4 paratypes, locality same as E4751.
E5106, paratype, north-east of Babel Island, Bass Strait, 180-306 m.
E5215, 2 paratypes, locality same as E4751.
E5216, paratype, locality same as E4751.
E5223, paratype, 20 miles east of Babel Island, Bass Strait, 117 m.
J2251, paratype, off Noosa Heads, Queensland, 28 m.
=*Comanthoides spanoschistum* (Clark) — see A. H. Clark, 1931, p. 241. (5 paratypes listed in the M.C.Z. catalogue cannot be found in the collection; Dr. D. Opresko, pers. comm.)
Note: H. L. Clark (1916) recorded 23 specimens. Although 21 are recorded in the M.C.Z. and The Australian Museum, with the 5 specimens missing from the M.C.Z. collections a total of seven specimens cannot now be found.

thetidis, Oligometra H. L. Clark (1909, p. 523, pl. 47, figs. 1-3).
J834, syntype, off Wollongong, New South Wales, 99-101 m, sand and mud to rock.
J819, 9 syntypes, locality same as J834.
=*Austrometra thetidis* (Clark) — see A. H. Clark, 1916, p. 115. (4 syntypes in the M.C.Z.)
Note: Fifteen specimens were recorded by H. L. Clark (1909), one has not been found.

zebra, Oligometra H. L. Clark (1916, p. 22, pl. 2, fig. 2).
E6301, holotype, 11 miles east south-east of mouth of Clarence River, New South Wales, 63-64 m.
=*Decametra zebra* (Clark) — see H. L. Clark, 1946, p. 52.

ASTEROIDEA

acanthodes, Anthenea H. L. Clark (1938, p. 124, pl. 18, fig. 2).
J5367, holotype, off Gatecombe Head, Port Curtis, Queensland, 16-21 m, July, 1929.

acanthodes, Echinaster H. L. Clark (1916, p. 61, pl. 19, figs. 1-2, text-fig. 7).
J2194, holotype, 25 miles south-east of Double Island Point, Queensland, 59 m.
J2080, paratype, 13 miles north-east of North Reef, Capricorn Group, off Port Curtis, Queensland, 126-133 m. (1 paratype in M.C.Z.)

acanthodes, Goniodiscaster H. L. Clark (1938, p. 84, pl. 5, fig. 2).
J6201, 3 paratypes, Broome, Western Australia, dredged, 12-15 m, firm sand, June 1932.

accrescens, Leptoptychaster Koehler (1920, p. 246, pl. LII, fig. 5; LIII, figs. 1-3; LIV, figs. 2-9; LV, fig. 1; LXXIV, fig. 1).
J3639, 2 syntypes (specimens K and L), 66°32'S, 141°39'E, 271 m, December 31, 1913.
J3640, 4 syntypes (specimens E, I, J and M) 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3679, syntype (specimen B) 66°32'S, 141°39'E, 271 m, December 31, 1913.
J3682, syntype (specimen C, D or H) 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3683, syntype (specimen C, D or H) 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3699, syntype (specimen A) 65°42'S, 92°19'E, 108 m, January 21, 1914.
J3712, syntype (specimen C, D or H) 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3713, syntype (specimen G) 66°55'S, 145°21'E, 572 m, December 28, 1913.
J3714, syntype (specimen F) 66°50'S, 142°6'E, 637 m, December 22, 1913.
=*Macroptychaster accrescens* (Koehler) — see H. E. S. Clark, 1963, p. 23.
Note: Specimens numbered J3679, J3682, J3683, J3699, J3712, J3713 and J3714 were not found in the collection, but were recorded as being destroyed in July, 1939, in the Museum Accessions Register. These records are included here to account for all type-specimens described in Koehler's (1920) report.

aculeatus, Pteraster Koehler (1920, p. 168, pl. XXXVIII, figs. 3-5; LXV, fig. 6).
J3521, holotype, 65°6'S, 96°13'E, 585 m, January 29, 1914.
=*Pteraster affinis aculeatus* (Koehler) — see A. M. Clark, 1962, p. 64.

adeliae, Anasterias Koehler (1920, p. 26, pl. I, figs. 1, 2, 5-10; LVI, fig. 1).
J3689, 2 syntypes, Adeliae, 21 m, September 3-4, 1912.
=*Lysasterias adeliae* (Koehler) — see A. M. Clark, 1962, p. 89.
Note: These specimens were destroyed in 1939, see note under *Leptoptychaster accrescens.*

alba, Asterina H. L. Clark (1938, p. 150, pl. 22, fig. 7).
J6170, 6 paratypes, Ned's Beach, Lord Howe Island, April, 1932.

asperatus, Solaster Koehler (1920, p. 157, pl. XXXIII, figs. 8-9; LXV, fig. 3).
J3600, holotype, 64°32'S, 97°20'E, 198 m, January 31, 1914.
=*Paralophaster godfroyi asperatus* (Koehler) — see A. M. Clark, 1962, p. 53.

atyphoida, Asterina H. L. Clark (1916, p. 57, pl. 17, figs. 1-2).
E6303, holotype, 15 miles north-west of Cape Jervis, South Australia, 30 m.
E859, 2 paratypes, off Cape Marsden, Kangaroo Island, South Australia, 30 m. (1 paratype in M.C.Z.)

aurorae, Cryaster Koehler (1920, p. 120, pl. XXVII, figs. 1-3, 5-6; XXVIII, figs. 1-11; XXIX, figs. 2-6; XXX, figs. 2-5).
J3659, 1 syntype (specimen K), Adelie Land, 45 m, September 3-4, 1912.
J3658, 8 syntypes (specimens C, D, E, F, G, H, I, J), 65°42'S, 92°10'E, 108 m, January 21, 1914.

J3690 and J3698, 3 specimens of which only 1 can be a syntype (specimen A), this not being determinable from labels with these specimens, 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3668, J3670, J3684, J3685, J3686, J3687, J3701, 10 specimens (only 2 can be syntypes (specimens B and L), see J3690, J3698), 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3728, 2 specimens of which only 1 can be a syntype (specimen M) (see J3690, J3698), *66°32'S, 141°39'E, 271 m, December 31, 1913.*
=*Perknaster aurorae* (Koehler) — see A. M. Clark, 1962, p. 31.
Note: Specimens numbered J3690, J3698, J3668, J3670, J3684-7, J3701, J3728 were destroyed in 1939. See note under *Leptoptychaster accrescens.*

australiensis, Mediaster H. L. Clark (1916, p. 39, pl. 9, figs. 1-2, text figs. 1-3).
J1535, holotype, east coast of Flinders Island, Bass Strait, 72 m.
E5093, 2 paratypes, east of Babel Island, Bass Strait, 117-126 m.
J1537, paratype, Oyster Bay, Tasmania. (4 paratypes in M.C.Z.)
Note: One of the specimens in the M.C.Z. is an Australian Museum registered specimen "exchanged with Clark in 1911" according to the departmental Accessions Register. It is likely that this is not a type-specimen even though so labelled.

australis, Odinia H. L. Clark (1916, p. 75, pl. 27, figs. 1-2).
E4730, holotype, south-east of Cape Everard, Victoria, 360 m.
=*Novodinia australis* (Clark) — see Dartnall et al, 1969, p. 211. (1 paratype in M.C.Z.)

bicolor, Goniodiscaster H. L. Clark (1938, p. 87, pl. 5, fig. 1).
J6197, paratype, Broome, Western Australia, 1932.

boardmani, Pseudarchaster Livingstone (1934, p. 177, pl. 18, figs. 7-11).
J5633, holotype, off Cape Everard, New South Wales, 135 m.
J5035-7, 3 paratypes, 24 miles N.N.E. off Montagu Island, New South Wales, 144-162 m.
=*Mediaster boardmani* (Livingstone) — see H. L. Clark, 1946, p. 83.

brachiata, Saliasterias Koehler (1920, p. 54, pl. XI, figs. 1-4; XII, figs. 1-8; LVIII, fig. 3).
J3547, syntype (specimen A), 66°50'S, 142°6'E, 637 m, December 22, 1913.
J3548, syntype (specimen C), Adelie Land, 27-37 m, January 20, 1913.
J3703, syntype (specimen B), 66°50'S, 142°6'E, 637 m, December 22, 1913.
Note: Specimen numbered J3703 destroyed in 1939. See note under *Leptoptychaster accrescens.*

brevispina, Patiriella H. L. Clark (1938, p. 166, pl. 22, figs. 2-3).
J6181, 2 paratypes, Koombara Bay, Bunbury, Western Australia, 9-14 m, October 26, 1929.

confertus, Ophidiaster H. L. Clark (1916, p. 53, pl. 15, figs. 1-2).
J11, holotype, Lord Howe Island. (2 paratypes in M.C.Z.)

conspicuus, Pseudontaster Koehler (1920, p. 202, pl. XLII, figs. 1-7; XLIII, figs. 1-10; LXX, fig. 1).
J3610, syntype (specimen B), 66°50'S, 142°6'E, 637 m, December 22, 1913.
J3616, syntype (specimen A), 66°50'S, 142°6'E, 637 m, December 22, 1913.
J3611, syntype (specimen C), Adelie Land, 45 m, September 3-4, 1912.
J3615, syntype (specimen E), Adelie Land, 45 m, September 3-4, 1912.
J3612, syntype (specimen H), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3613, syntype (specimen G), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3614, syntype (specimen F), 66°32'S, 141°39'E, 271 m, December 31, 1913.
J3739, syntype (specimen D), 66°50'S, 142°6'E, 637 m, December 22, 1914.
=*Acodontaster conspicuus* (Koehler) — see A. M. Clark, 1962, p. 16, except J3611 = A.

waitei (Koehler) — see Bernasconi, 1970, p. 236.
Note: Specimen numbered J3739 destroyed 1939. See note for *Leptoptychaster accrescens.*

coriaceus, Hymenaster Koehler (1920, p. 173, pl. XXXIX, figs. 1-2).
J3671, holotype, 35°44'S, 135°58'E, 3240 m, February 25, 1914.

crassa, Anthenea H. L. Clark (1938, p. 124, pl. 18, fig. 1).
J5368, holotype, Rat Island, Port Curtis, Queensland, July, 1929.
J5365, paratype, off Gatecombe Head, Port Curtis, Queensland, 16-21 m, July, 1929.
J5366, paratype, locality same as J5365.
J5444, paratype, Port Curtis, Queensland, 21 m.
J5445, paratype, locality same as J5444.
G4980, paratype, Port Curtis, Queensland, 18 m.

directus, Parastichaster Koehler (1920, p. 97, pl. XX, figs. 8-11; XXI, figs. 8-12; XXII, figs. 1-2; LXII, fig. 2).
J3636, 2 syntypes (specimens A, B), Macquarie Island, south-west of New Zealand, low tide, October 10, 1913.
J3836, 2 syntypes (specimens C, D), Macquarie Island, low tide, October 10, 1913.
=*Anasterias directa* (Koehler) — see A. M. Clark, 1962, p. 97.
Note: Specimens numbered J3836 destroyed 1939. See note for *Leptoptchaster accrescens.*

dubia, Coscinasterias H. L. Clark (1909, p. 532, pl. 49, figs. 3-4, pl. 50).
J1024, syntype, of Botany Bay, New South Wales, 36-41 m, sand to rock.
J1033-4, 2 syntypes, locality same as J1024.
J1025, syntype, "Thetis" station unknown.
J1026, syntype, locality same as J1025.
J1027, syntype, locality same as J1025.
J1030, syntype, locality same as J1025.
G11432, syntype, locality same as J1025.
J932, syntype, off Coogee, New South Wales, 88-90 m, fine sand.
=*Australiaster dubia* (Clark) — see Fisher, 1923, p. 253. (6 syntypes in M.C.Z.)
Note: Of the 6 syntypes in the M.C.Z., 2 are listed from the coast of New South Wales and may be from the total of 10 from "Thetis" station? This would then leave 2 specimens unaccounted for from that station. Three specimens are listed from Oyster Bay, Tasmania, but H. L. Clark (1909) does not record specimens of this species from that location. Either the locality labels have been mixed or the specimens were identified after the "Thetis" report was published, in which case they do not qualify as type-specimens. One specimen from "Thetis" station 36 (Botany Bay) is listed in the M.C.Z. catalogue but not found in the collections. This may be because the 3 specimens recorded from that station can be accounted for in the Australian Museum collections. Although only 14 specimens were reported by H. L. Clark (1909), a total of 16 are represented by those recorded in the two institutions. The confusion of locality records may account for this discrepancy.

dubius, Anthenoides H. L. Clark (1938, p. 91, pl. 17, figs. 5-6).
J6113, paratype, Broome, Western Australia, 9-14 m, dredged June, 1932.

dyscrita, Cosmasterias H. L. Clark (1916, p. 71, pl. 29, figs. 1-2).
E4704, holotype, South of Gabo Island, Victoria, 360 m.

elegans, Anthenea H. L. Clark (1938, p. 126, pl. 18, fig. 4).
J6200, paratype, Broome, Western Australia, 9-14 m, June, 1932.

emburyi, Tegulaster Livingstone (1933, p. 12, pl. 1, figs. 1, 3; pl. 2, figs. 2-3, 6, 9).
J5606, holotype, Norwest Island, Capricorn Group, Queensland, under dead coral boulder.

erucaradiatus, Calliaster Livingstone (1936, p. 383, pl. 27).
J5996, holotype, Crowdy Head, New South Wales, bearing north by west, 11 miles, 90 m, September, 1935.

flexuosus, Leptoptychaster Koehler (1920, p. 252, pl. LI, figs. 1-4; LXXV, fig. 3).
J3662, holotype, 66°55'S, 145°21'E, 572 m, December 28, 1913.
=*Leptychaster flexuosus* (Koehler) — see A. M. Clark, 1962, p. 10.

florifer, Pteraster Koehler (1920, p. 170, pl. XXXVIII, fig. 1-2, 6-7; LXV, fig. 10).
J3519, holotype, 64°34'S, 127°17'E, 3060 m, January 6, 1914.

fochi, Podasterias Koehler (1920, p. 35, pl. XIV, figs. 1-2, 4-12; XV, figs. 1-3; XVI, figs. 2-3 and 7; LVIII, fig. 1).
J3663, 2 syntypes (specimens A and B), 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3673, J3677 and J3681, 3 specimens of which only 2 can be syntypes (specimens D and E), this not being determinable in the absence of these specimens. Commonwealth Bay, Adelie Land, 630-720 m, September 3-4, 1912.
J3669, syntype (specimen C), 166°32'S, 141°39'E, 271 m, December 31, 1913.
=*Diplasterias brucei* (Koehler) — see A. M. Clark, 1962, p. 83.
Note: Specimens numbered J3673, J3677, J3681 and J3669 destroyed in 1939. See note for *Leptoptychaster accrescens.*

formatus, Pedicellaster Koehler (1920, p. 106, pl. XVI, figs. 1, 9-10; XVII, figs. 6-7; LVIII, fig. 4).
J3556, holotype, 66°8'S, 94°17'E, 216 m, January 21, 1914.
=*P. hypernotius formatus* (Koehler) — see A. M. Clark, 1962, p. 71.

glomeratus, Echinaster H. L. Clark (1916, p. 62, text-fig. 8, pls. 22-23).
J1624, holotype, off Cape Marsden, Kangaroo Island, South Australia, 30 m.
E6789, 2 paratypes, locality same as J1624. (2 paratypes in M.C.Z.)
Note: All 6 specimens recorded by H. L. Clark (1916) were from off Cape Marsden, however, one of the M.C.Z. specimens is from an unknown locality. Also, one specimen cannot be found.

gracilis, Mimaster H. L. Clark (1916, p. 33, pl. 7, figs. 1-2).
E4710, holotype, south of Gabo Island, Victoria, 360 m.
E4708, paratype, locality same as E4710.
E4709, paratype, locality same as E4710.
=*Radiaster gracilis* (Clark) — see H. L. Clark, 1946, p. 80. (2 paratypes in M.C.Z)
Note: According to H. L. Clark (1916), only the holotype was collected from south of Gabo Island, Victoria, so it is difficult to account for two of the paratypes in the Australian Museum and one of the paratypes in the M.C.Z. which are recorded from that locality.

hamiltoni, Asterina Koehler (1920, p. 133, pl. XXXV, figs. 5-8; XXXVI, figs. 1-3; LXVI, fig. 5).
J3520, holotype, Macquarie Island, south-west of New Zealand.

haswelli, Notasterias Koehler (1920, p. 70, pl. 1, fig. 11; VI, fig. 4; VII, figs. 1-7; IX, fig. 7; LXII, fig. 1).
J3514, 3 syntypes (specimens A, B, C), 65°42'S, 92°10'E, 108 m, January 21, 1914.
J8446, syntype (specimen D), 66°50'S, 142°6'E, 637 m, December 22, 1913.

heffernani, Ferdina Livingstone (1931, p. 306, pl. 24, figs. 1-5).
J5089, holotype, south-east side of Santa Cruz Island, Santa Cruz Group, western Pacific,

August, 1926.
=*Celerina heffernani* (Livingstone) — see A. M. Clark, 1967, p. 193.

heteractis, Henricia H. L. Clark (1909, p. 530, pl. 49, figs. 1-2).
G11430, holotype, Lord Howe Island.
J830, 2 paratypes, locality same as G11430.
=*Nepanthia belcheri* (Perrier) — see H. L. Clark, 1938, p. 169. (2 paratypes in M.C.Z.)

hirsutus, Echinaster Koehler (1920, p. 113, pl. XII, fig. 9; XXIV, figs. 6-9; LXVI, fig. 2).
J3526, holotype, 66°32′S, 141°39′E, 271 m, December 31, 1913.
=*Rhopiella hirsuta hirsuta* (Koehler) — see A.M. Clark, 1962, p. 39.

hunteri, Pteraster Koehler (1920, p. 165, pl. XXXVII, figs. 4-10; XXXVIII, fig. 8; LXV, fig. 8).
J3571, syntype (specimen D), 65°6′S, 96°13′E, 585 m, January 29, 1914.
J3570, syntype (specimen A), 65°.6′S, 96°13′E, 585 m, January 29, 1914.
J3569, syntype (specimen B), 64°44′S, 97°28′E, 644 m, January 31, 1914.
J3568, 2 syntypes (specimens C and E), 64°32′S, 97°20′E, 198 m, January 31, 1914.
=*P.* (*Apterodon*) *stellifer hunteri* Koehler — see A.M. Clark, 1962, p. 66.

incurvatus, Kampylaster Koehler (1920, p. 138, pl. XXXVI, figs. 4, 5, 6, 7, 11; XXXVII, figs. 1-3; LXVI, fig. 8).
J3581, 2 syntypes (specimens A and B), 166°32′S, 141°39′E, 271 m, December 31, 1913.

inopinata, Asterina Livingstone (1933, p. 3, pl. 5, figs. 1-8, 14).
J3077, holotype and 12 paratypes, Long Reef, Collaroy, near Sydney, New South Wales.

inornata, Patiriella Livingstone (1933, p. 17, pl. 1, figs. 2, 4, pl. 2, figs. 1, 4, 7).
J3198, holotype, Western Australia.

insolita, Neoferdina Livingstone (1936, p. 384, pl. 28, figs. 2, 4, 6).
J5775, holotype, reef at Samarai, Papua.

inspinosus, Stellaster H. L. Clark (1916, p. 48, pl. 13, figs. 1-7).
E2503, holotype, between Cape Naturaliste and Geraldton, Western Australia. (1 paratype in M.C.Z.)

integer, Goniodiscaster Livingstone (1931, p. 135, pls. 17-19).
J5499, holotype, Port Curtis, Moreton Bay, Queensland, dredged 21 m, December, 1929.
J5500, paratype, locality same as J5499.
J5501, paratype, locality same as J5499.
G11502, 2 paratypes, near Peel Island, Moreton Bay, Queensland.

joffrei, Podasterias Koehler (1920, p. 30, pl. 1, figs. 3, 4, 9; II, figs. 7-9; LVI, fig. 2).
J3642, holotype, 66°50′S, 142°6′E, 637 m, December 22, 1913.
=*Lysasterias joffrei* (Koehler) — see A.M. Clark, 1962, p. 93.

laevis, Archaster H. L. Clark (1938, p. 75, pl. 17, fig. 2).
J6116, 3 paratypes, vicinity of Roebock Bay and Southward, Broome, Western Australia, 9-14 m, June 1932.

laseroni, Tridontaster Koehler (1920, p. 214, pl. XLVII, figs. 7-10; XLVIII, figs. 1, 7; LXIX, fig. 5).
J3618 (part), holotype (specimen B), 64°32′S, 97°20′E, 198 m, January 31, 1914.
J3618 (part), paratype (specimen C), locality same as J3618.
J8447, paratype (specimen A), 65°42′S, 92°10′E, 108 m, January 21, 1914.
J3675, paratype, Adelie Land, Antarctica, 45 m, September 3-4, 1912.
=*Acondontaster hodgsoni* (Bell) — see A. M. Clark, 1962, p. 20.
Note: Specimen numbered J3675 destroyed in 1939. See note for *Leptoptychaster accrescens*.

leptalacantha, Asterina H. L. Clark (1916, p. 57, pl. 18, figs. 3-4).
J3082, holotype, Masthead Island, Capricorn Group, Queensland, December, 1913.
=*Disasterina leptalacantha* (Clark) — see Livingstone, 1933, p. 8.

littoralis, Marginaster Dartnall (1970, p. 207, pl. 13, figs. 1-2).
J7733, 4 paratypes, Powder Jetty, near Hobart, Derwent Estuary, S.E. Tasmania, May 2, 1969.
J7734, 7 paratypes, Cornelian Bay, S.E. Tasmania, May 2, 1969.

longispinus, Ripaster Koehler (1920, p. 260, pl. LI, figs. 5-8; LII, figs. 3-4; LXXII, fig. 2).
J3661, syntype (specimen D), 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3665, syntype (specimen E, F, or G), 65°6'S, 96°13'E, 585 m, January 29, 1914.
J3666, syntype (specimen B), 66°32'S, 141°19'E, 271 m, December 31, 1913.
J3711, syntype (specimen A), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J3710, 2 syntypes (specimens E, F, or G), 65°6'S, 96°13'E, 585 m, January 29, 1914.
=*Psilaster charcoti* (Koehler) — see A. M. Clark, 1962, p. 13.
Note: Specimens numbered J3665, J3666, J3711, J3710 destroyed 1939. See note for *Leptoptychaster accrescens.*

lutea, Asterina H. L. Clark (1938, p. 153, pl. 12, fig. 2).
J6167, 4 paratypes, Broome, Western Australia, August-September 1929.

macleani, Peribolaster Koehler (1920, p. 161, pl. XXXI, figs. 4-6; XXXIII, figs. 1-2; LXVIII, fig. 4).
J3609, paratype (specimen D), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J3525 (part), holotype (specimen A), 66°32'S, 141°39'E, 271 m, December 31, 1913.
J3523 (part), paratype (specimen B), locality as for J3523.
J8448, paratype (specimen C), 64°32'S, 97°20'E, 198 m, January 31, 1914.

macquariensis, Cycethra Koehler (1920, p. 139, pl. XXXIV, figs. 1-4, 6-7; LXVI, fig. 5 a, b).
J3605, holotype, Macquarie Island, south-west of New Zealand, October 10, 1913.

macracantha, Zoroaster H. L. Clark (1916, p. 68, pl. 28, figs. 1-1).
E3705, holotype, Great Australian Bight, 129°28'E, south from Eucla, 450-810 m.
J3068, paratype, locality same as E3705. (1 paratype in M.C.Z.)

magnificus, Lonchotaster H. L. Clark (1916, p. 30, pl. 6, figs. 1-2).
E3650, holotype, Great Australian Bight, 32-36 m, March-April 1913.
=*Dipsacaster magnificus* (Clark) — see Fisher, 1919, p. 150.

mamillifera, Nardoa Livingstone (1930, p. 20, pl. 7, figs. 1-5).
J1197, holotype, Mer, Murray Islands, Torres Strait.

mawsoni, Parastichaster Koehler (1920, p. 91, pl. XIX, figs. 1-8; XX, fig. 1; XXI, figs. 1-6; fig. 4; XXIV, fig. 5; XXVIII, fig. 3; LXIII, fig. 2).
J3638, 4 syntypes (specimens A, C, E, F), Macquarie Island, south-west of New Zealand, October 10, 1913.
J3797, syntype (specimen B), Macquarie Island, October 10, 1913.
J3721, syntype (specimen D), Macquarie Island, October 10, 1913.
=*Anasterias mawsoni* (Koehler) — see A. M. Clark, 1962, p. 96.

mimica, Patiriella Livingstone (1933, p. 16, pl. 1, figs. 6-7, pl. 2, figs. 8, 10-11).
J1696, holotype, Newcastle Bight, New South Wales, 28-35 m.

monacanthus, Mediaster H. L. Clark (1916, p. 41, text-figs. 4, pl. 10, figs. 1-2).
J2098, holotype, 6 miles east of Cape Hawke, New South Wales, 84-90 m.
J2095, paratype, locality same as J2098.
J2082, paratype, locality same as J2098.

E1621, 4 paratypes, locality same as J2098.
=*Nectriaster monacanthus* (H. L. Clark) — see H. L. Clark, 1946, p. 84. (Of 3 paratypes listed in the M.C.Z. catalogue 2 cannot be found in the collections; Dr. D. Opresko, pers. comm.)

multispinus, Crossaster H. L. Clark (1916, p. 66, pl. 18, figs. 5-6).
E5293, holotype, off south-east Australia, between Gabo Island, Victoria and Disaster Bay, New South Wales, 90-180 m.
E5078, 2 paratypes, 35 miles south-east of Bruni Island, Tasmania, 270-314 m. (1 paratype in M.C.Z.)

nigra, Patiriella H. L. Clark (1938, p. 167, pl. 21, figs. 3-4).
J4439, paratype, Lord Howe Island.

obscura, Patiriella Dartnall (1971, p. 45, pl. IV(b)).
J7791, 6 paratypes, Rose Bay, Bowen, Queensland, April 13, 1970.

occidentalis, Parasterina H. L. Clark (1938, p. 180, pl. 21, fig. 5).
J6178, paratype, near Fremantle, Western Australia.

pentagonalis, Epidontaster Koehler (1920, p. 235, pl. XXXVIII, figs. 3, 4, 8; XLI, figs. 3, 10, 11; LXXI, fig. 3).
J3542, holotype, 66°8'S, 4°17'E, 216 m, January 21, 1914.
=*Odontaster meridionalis* (Smith) — see A. M. Clark, 1962, p. 15.

pentagonus, Nymphaster H. L. Clark (1916, p. 36, pl. 7, figs. 1-2).
E3707, holotype, Great Australian Bight, 129°28'E, 450-810 m.

polygnatha, Anthenea H. L. Clark (1938, p. 128, pl. 18, fig. 3, pl. 19, figs. 2-3).
J6118, paratype, south and south-west of Roebuck Bay, Broom, Western Australia, 9-14 m, June 1932.

polypora, Fromia H. L. Clark (1916, p. 51, pl. 14, figs. 1-2).
E5018, holotype, east of Maria Island, Tasmania, 140 m.
=Austrofromia polypora (Clark) — see H. L. Clark, 1921, p. 48. (1 paratype in the M.C.Z.) M.C.Z.)
Note: Three specimens were recorded by H. L. Clark (1916), one has not been found.

praesignis, Disasterina Livingstone (1933, p. 10, pl. 1, figs. 5-8, pl. 2, fig. 5).
J5059, holotype, North Channel, off Curtis Island, Port Curtis, Queensland, 5-7 m, July, 1929.

praestans, Mediaster Livingstone (1933, p. 21, pl. 6).
J5618, holotype, off Cairns, Queensland, dredged.

praetermissa, Asterinopsis Livingstone (1933, p. 14, pl. 3, figs. 1-2, pl. 4, figs. 2-3).
J4793, holotype, Little Bay, south of Port Jackson, New South Wales, under stones in pools between tidemarks.
J1911, paratype, Port Jackson, New South Wales.
J1913, paratype, locality same as J1911.
J3196, paratype, locality same as J1911.
=*Paranepanthia praetermissa* (Livingstone) — see H. L. Clark, 1938, p. 161.

propinquus, Ophidiaster Livingstone (1932, p. 255, pl. 13, figs. 5, 11, 16, 18).
J5533, holotype, Ribbon Reef, Great Barrier Reef, Queensland, seaward sloping zone, June 4, 1929.
=*Linckia laevigata* (Linnaeus) — herein assigned after correspondence with Mrs. L. Marsh, The Western Australian Museum, Perth.

pseudoexigua, Patiriella Dartnall (1971, p. 43, pl. IV(a)).
J7761, 2 paratypes, Airlie Beach, Proserpine, Queensland, intertidal, under rocks, September and October, 1968.

pterasteroides, Echinaster Koehler (1920, p. 115, pl. XVI, figs. 4, 5, 8; XXV, figs. 3-5).
J3510, holotype, 64°44'S, 97°28'E, 644 m, January 31, 1914.
=*Rhopiella hirsuta hirsuta* (Koehler) — see A. M. Clark, 1962, p. 39.

pudicus, Hymenaster Koehler (1920, p. 175, pl. XXXVI, figs. 8-10).
J3567, 2 syntypes (specimens A and B), 35°44'S, 135°58'E, 3240 m, February 25, 1914.

queenslandensis, Tosia Livingstone (1932, p. 243, pl. 5, figs. 1-2, 7).
J5534, holotype, Pixie Reef, Great Barrier Reef, Queensland, June 6, 1929.

reticulatus, Pedicellaster H. L. Clark (1916, p. 69, pl. 27, figs. 3-4).
E5021, holotype, east of Maria Island, Tasmania, 140 m.

rhysus, Pseudophidiaster H. L. Clark (1916, p. 55, pl. 16, figs. 1-2).
E3656, holotype, Great Australian Bight, 144-216 m.
E607, paratype, Oyster Bay, Tasmania, 108 m.
E3653, paratype, locality same as E3656.
E3654, paratype, locality same as E3656.
E4715, paratype, south of Gabo Island, Victoria, 360 m. (2 paratypes in M.C.Z.)

rosea, Paranepanthia H. L. Clark (1938, p. 161, pl. 22, fig. 8).
J6171, 3 paratypes, Rottnest Island, Western Australia.

scobinata, Asterina Livingstone (1933, p. 1, pl. 5, figs. 9-12 and 15).
J1241, holotype, Tasmania
G11522, 2 paratypes, locality same as J1241.

smilax, Echinaster Koehler (1920, p. 111, pl. XII, fig. 10; XXV, figs. 1, 2, 6, 7; LXVI, fig. 1).
J8449, syntype (specimen C), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3816, 2 syntypes (specimens D and E), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J3555, 2 syntypes (specimens A and B), 66°8'S, 94°17'E, 216 m, January 21, 1914.
=*Henricia smilax* (Koehler) — see A. M. Clark, 1962, p. 43.

sphoerulatus Parastichaster Koehler (1920, p. 101, pl. XXI, fig. 7; XXIII, figs. 5-10; XXIV, figs. 1-4; LXIII, fig. 3; LXIV, figs. 1-2).
J3637, 2 syntypes (specimens A and B), Macquarie Island, south-west of New Zealand, October, 1913.
=*Anasterias sphoerulatus* (Koehler) — see A. M. Clark, 1962, p. 96.

spinosus, Calliaster H. L. Clark (1916, p. 44, pl. 11, figs. 1-2).
E4682, holotype, eastern slope, Bass Strait, 144-360 m.

stellatus, Pseudontaster Koehler (1920, p. 210, pl. L, figs. 1-7; LXX, fig. 2).
J3515, holotype, 64°32'S, 97°20'E, 151 m, January 31, 1914.
=*Acodontaster hodgsoni stellatus* (Koehler) — see A. M. Clark, 1962, p. 21.

superbus, Echinaster H. L. Clark (1916, p. 64, text-figs. 9-10, pl. 24-25).
J2030, holotype, Broome, Western Australia.

tenuis, Lophaster Koehler (1920, p. 151, pl. XXXII, figs. 1-7; LXVIII, fig. 5).
J3533, holotype, 64°32'S, 97°20'E, 151 m, January 31, 1914.

tenuis, Nepanthia H. L. Clark (1938, p. 175, pl. 20, fig. 3).
J6176, paratype, Broome, Western Australia, June 1932.

tesselatus, Pergmaster Koehler (1920, p. 238, pl. XLIV, figs. 2, 3, 5-17).
J3459, 2 syntypes (specimens A and B), 64°34'S, 127°17'E, 3060 m, January 6, 1914.
=*P. incertus* (Bell) — see A. M. Clark, 1962, p. 23.

tetracanthus, Pteraster H. L. Clark (1916, p. 67, pl. 18, fig. 1-2).
E5295, holotype, south-east of Cape Everard to south of Gabo Island, Victoria, 162-270 m.

troughtoni, Parasterina Livingstone (1934, p. 179, pl. 18, figs. 1-6).
J3978, holotype, shore at Albany, King George's Sound, Western Australia.

truncatus, Asterodiscus Coleman (1911, p. 699).
J1053, syntype, coast of New South Wales.
J2047, syntype, off east coast of Victoria.

variabilis, Nepanthia H. L. Clark (1938, p. 176, pl. 10, figs. 4-5, pl. 20, figs. 4-5).
J6107, 4 paratypes, Broome, Western Australia, August 26, 1929.

varicolor, Echinaster H. L. Clark (1938, p. 184, pl. 11, fig. 1).
J6184, 3 paratypes, vicinity of Broome, Western Australia, 9-14 m, sandy bottom, June, 1932.

variegatus, Bunaster H. L. Clark (1938, p. 134, pl. 22, fig. 1).
J6177, paratype, Bathurst Point, Rottnest Island, Western Australia.

victoriae, Anasterias Koehler (1920, p. 17, pl. II, fig. 5; III, figs. 1-6; IV, figs. 1-4; V, figs. 1-10; VI, figs. 1-4; LVII, fig. 1).
J3635, 6 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J8444, syntype (specimen C), 66°50'S, 142°6'E, 637 m, December 22, 1913.
J8445, syntype (specimen K), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J3629, syntype (specimen G), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3841, syntype (specimen I), locality as for J3635.
J3826, 2 syntypes (specimens A and B), locality as for J3635.
=*Lysasterias perrieri* (Studer) — see A. M. Clark, 1962, p. 89.
Note: Specimens numbered J3841 and J3826 destroyed in 1939. See note for *Leptoptychaster accrescens.*

waitei, Metadontaster Koehler (1920, p. 219, pl. XLV, figs. 1-6; XLVII, figs. 5-6; XLVIII, fig. 8; LXIV, figs. 1-3; LXXI, figs. 1-2).
J8453, paratype (specimen C), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3664, holotype (specimen B), 66°50'S, 142°6'E, 637 m, December 22, 1913.
J3680, paratype (specimen A), Adelie Land, Antarctica, 45 m, September 3-4, 1912.
=*Acodontaster waitei* (Koehler) — see A. M. Clark, 1962, p. 21.
Note: Specimen numbered J3680 destroyed 1939. See note for *Leptoptychaster accrescens.*

wardi, Pseudogoniodiscaster Livingstone (1930, p. 16, pl. 4, figs. 1-2, pl. 5, figs. 1-3).
J5320, holotype, among weed, Rat Island, Port Curtis, Queensland, July 1929.

watsoni, Ophidiaster Livingstone (1936, p. 386, pl. 28, figs. 1, 3, 5, 7).
J5997, holotype, Bushy Island, off Mackay, Queensland, July 1933.
=*Gomophia aegyptiaca* Gray — herein assigned.

OPHIUROIDEA

accomodata, Ophiurolepis Koehler (1922, p. 67, pl. LXXXIV, figs. 7-11 and 17).
J3601, 3 syntypes (specimens A, B, and C), Maria Island, Tasmania, 2340 m, December 13, 1912.

acestra, Ophiothrix H. L. Clark (1909, p. 544, pl. 53, figs. 4-5).
J869, syntype, Shoalhaven Bight, sand to mud, 34-36 m. (1 syntype in M.C.Z.)

acosmeta, Ophiactis H. L. Clark (1938, p. 262).
J6369, 2 paratypes, Port Curtis, Queensland.
J6241, 4 paratypes, Broome, Western Australia, 9-14 m, June, 1932.

alternans, Ophiocoma Endean (1964, p. 295, pl. 1, fig. 1).
J7344, holotype, Hastings Point, northern New South Wales, rock pool L.W.N., April 16, 1961.
J7345, 23 paratypes, same locality as J7344.
=*O. endeani* nom. nov. pro. *O. alternans* Endean non *O. alternans* v. Martens, 1870, p. 251 =*O. scolopendrina* (Lamarck), according to Lyman, 1874, p. 225.

amator, Ophiactis Koehler (1922, p. 34, pl. LXXXI, figs. 1-6).
J3563, syntype, 60°32′S, 141°39′E, 282 m, December 31, 1913.
J3562, 3 syntypes, Maria Island, 540 m, December 13, 1912.

amblyconus, Conocladus H. L. Clark (1909, p. 549, pl. 55).
G11434, holotype, Off Cape Three Points, New South Wales, 41-44 m, sand.
J835, paratype, off Port Kembla, New South Wales, 113-135 m.
J931, paratype, off Crookhaven River, New South Wales, 41 m.
J1044, paratype, locality same as J931, 19-27 m.
J1045-6, 2 paratypes, off Coogee, New South Wales, 89-90 m.
J1054-5, 1057-8, 4 paratypes, within Jervis Bay, New South Wales, 18-19 m. (5 paratypes in M.C.Z.)
Note: Of the 19 specimens recorded by H. L. Clark (1909), 15 appear to be accounted for, although the number of specimens listed from off Coogee, in the M.C.Z. and The Australian Museum collections, is 7 instead of the 6 reported by Clark. Also, 2 specimens from off Jervis Bay and 3 from an unknown "Thetis" station have not been found.

amphilogus, Ophiodesmus Ziesenhenne (1940, p. 33, pl. 9, figs. 4-6).
J7400, paratype, south of Cerros Island, Lower California, Mexico, 18-27 m, March 10, 1934 ("Velero" stn. 278-34).

applicatus, Ophiocamax Koehler (1922, p. 17, pl. LXXVIII, figs. 1-3 and 13).
J3518, syntype, off Maria Island, Tasmania, 2340 m, December 13, 1912.
J3732, syntype, off Maria Island, Tasmania, 2340 m, December 13, 1912.
Note: Specimen numbered J3732 destroyed in 1939. See note for *Leptoptychaster accrescens.*

atra, Ophiothrix stelligera H. L. Clark (1938, p. 274).
J6301, 2 paratypes, La Grange Bay, near Broome, Western Australia, September, 1929.
=*Ophiothrix ciliaris rugosa* Koehler — herein assigned.

atrolineata, Ophiothrix stelligera H. L. Clark (1938, p. 274).
J6237, 2 paratypes, Broome, Western Australia, June 1932.
=*Ophiothrix ciliaris melanogramma* (Bell) — see A. M. Clark and F. W. E. Rowe, 1971, p. 109.

australiana, Amphipholis H. L. Clark (1909, p. 540, pl. 52, figs. 1-3).
J857, syntype, off Wata Mooli, New South Wales, 97-106 m, mud.
J839, 4 syntypes, locality same as J857.
=*Amphipholis squamata* (Delle Chiaje) — see H. L. Clark, 1946, p. 202. (2 syntypes in M.C.Z.)

australiensis, Astroporpa H. L. Clark (1909, p. 547, pl. 54, fig. 2).
G11433, holotype, off Wollongong, New South Wales, 99-100 m, sand and mud to rock.
=*Asteroporpa australiensis* Clark — see H. L. Clark, 1916, p. 80.

axiologus, Ophiopristis H. L. Clark (1909, p. 543, pl. 53, figs. 1-3).
J920, holotype, off Wata Mooli, New South Wales, 97-106 m.
=*Ophioprium axiologus* (Clark) — see H. L. Clark, 1915, p. 216.

bidentata, Amphiura H. L. Clark (1938, p. 218, fig. 13).
J6242, 2 paratypes, Broome, Western Australia, 1932.
J6346, 2 paratypes, Port Curtis, Queensland.

bispinosa, Astrodia Koehler (1922, p. 11, pl. LXXVI, figs. 12-15).
J3855, 6 syntypes, 35°44'S, 135°58'E, 3240 m, February 25, 1914.
J3553, syntype, 35°44'S, 135°58'E, 3240 m, February 25, 1914.

californica, Ophiocnida Ziesenhenne (1940, p. 25, pl. 5, figs. 4-6).
J7395, paratype, Outer Gorda Bank, Lower California, Mexico, dredged, 108 m, April 7, 1937 ("Velero" stn. 750-37).

callista, Cryptopelta H. L. Clark (1938, p. 354, pl. 14, fig. 2).
J6306, paratype, Broome, Western Australia, June 1932.

colleta, Amphiophiura H. L. Clark (1916, p. 93, pl. 37, figs. 1-2).
E5100, holotype, east of Babel Island, Bass Strait, 108-144 m.

conferta, Ophioripa Koehler (1922, p. 19, pl. LXXXV, figs. 9-13).
J3579, 7 syntypes, Maria Island, Tasmania, 2340 m, December 13, 1912.

ctenophora, Ophiura H. L. Clark (1909, p. 537, pl. 51, figs. 4-6).
J865, syntype, in Shoalhaven Bight, New South Wales, 35-36 m.
J854, 2 syntypes, off Newcastle, New South Wales, 75-86 m.
J861, 3 syntypes, off Manning River, New South Wales, 39 m.
=*Dictenophiura ctenophora* (Clark) — see H. L. Clark, 1946, p. 268. (2 syntypes in M.C.Z.)

debitor, Ophiosteira Koehler (1922, p. 41, pl. LXXXII, figs. 1-4).
J3796, syntype, 60°32'S, 141°39'E, 282 m, December 31, 1913.
J3511, syntype, 66°32'S, 141°39'E, 271 m, December 31, 1913.

deficiens, Amphiura Koehler (1922, p. 28, pl. LXXX, figs. 1-4).
J3578, holotype, 60°32'S, 141°39'E, 282 m, December 31, 1913.
J8450, 2 paratypes, Adelie and 65°42'S, 92°10'E, 108 m, January 21, 1914.

delicata, Lissophiothrix H. L. Clark (1938, p. 276).
J6246, 2 paratypes, Broome, Western Australia, 9-14 m, 1932.
J6254, paratype, near Shell Islands, Port Darwin, Northern Territory, 5-10 m, July 24, 1929.

destinata, Amphiodia Koehler (1922, p. 32, pl. LXXIX, figs. 4-7).
J3546, 2 syntypes, 64°44'S, 97°28'E, 644 m, January 31, 1914.

diacritica, Amphiura H. L. Clark (1938, p. 222).
J5077, holotype, fringing reef, Black Island, Whitsunday Passage, Queensland.

dictyota, Ophionereis Ziesenhenne (1940, p. 29, pl. 6, fig. 1-5).
J7355, paratype, Secas Islands, Panama, in coral. February 4, 1935 ("Velero" stn. 447-35).

dolia, Amphiura H. L. Clark (1938, p. 224, fig. 14).
J6037, holotype, Port Jackson, New South Wales.
J6326, paratype, Port Jackson, New South Wales (a second paratype is apparently lost).

dyscrita, Pectinura H. L. Clark (1909, p. 534, pl. 49, fig. 5-7).
J849, syntype, off Wata Mooli, New South Wales, 126-140 m, coarse sand. (1 syntype in M.C.Z.)

echinulata, Ophiosteira Koehler (1922, p. 38, pl. LXXXII, figs. 5-10; LXXXIII, figs. 1-7).
J3719, 5 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3507, 3 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3508, 2 syntypes, Adelie Land, Commonwealth Bay, 81-90 m, December 14, 1913.
J3554, syntype, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3857, 4 syntypes, 66°8'S, 94°17'E, 216 m, January 27, 1914.
Note: One specimen included in J3719 is from Adelie Land, this being concluded from the original label in Koehler's hand. The total number of specimens from stn. 7 (65°42'S, 92°10'E) in Koehler's report is 6, however, we have found 8 specimens from that station. It is impossible to separate the two non-type specimens. It could be suggested that the number of specimens reported by Koehler might have been incorrect.

fragilis, Ophiocentrus H. L. Clark (1938, p. 238).
J6040, holotype, 22 miles east of Port Jackson Heads, New South Wales, 216 m.

fuscolineata, Ophiactis H. L. Clark (1938, p. 266).
J6233, 4 paratypes, Broome, Western Australia, 9-14 m, June 1932.
J6239, 2 paratypes, West Point, Port Darwin, Northern Territory, 5-14 m, October 26, 1929.

gigas, Ophiosparte Koehler (1922, p. 21, pl. LXXVII, figs. 1-8).
J3543, syntype, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3795, syntype, 64°32'S, 97°20'E, 198 m, January 13, 1914.
J3794, syntype, 65°42'S, 92°10'E, 108 m, January 21, 1914.
Note: Specimens numbered J3794 and J3795 destroyed 1939. See note for *Leptoptychaster accrescens.*

gymnopora, Ophiozona H. L. Clark (1909, p. 535, pl. 51, figs. 1-3).
J836, 78 syntypes, off Cape Three Points, New South Wales, 73-90 m.
J855, syntype, locality same as J836.
J822, 66 syntypes, Newcastle Bight, New South Wales, 46-72 m.
J824, 7 syntypes, off Port Hacking, New South Wales, 39-50 m.
J827, 7 syntypes, off Wata Mooli, New South Wales, 97-106 m.
J829, 7 syntypes, off Jibbon, New South Wales, 82-99 m.
=*Haplophiura gymnopora* (Clark) — see Matsumoto, 1915, p. 76. (72 syntypes in M.C.Z.)
Note: There are 34 specimens and 47 specimens missing from "Thetis" stations off Cape Three Points and Wata Mooli respectively.

hancocki, Ophioplocus Ziesenhenne (1935, p. 1, pl. 1, figs. 1-2).
J7360, paratype, Black Beach, Charles Island, Galapagos Islands, January 30, 1934, shore collection ("Velero" stn. 199-34).

heterotylota, Ophiacantha H. L. Clark (1909, p. 542, pl. 52, figs. 4-6).
J856, syntype, off Wata Mooli, New South Wales, 97-106 m, mud.
J859, 2 syntypes, off Port Hacking, New South Wales, 39-50 m, sandy. (8 syntypes in M.C.Z.)
Note: Ten specimens (J838) from off Crookhaven and 20 specimens (J821) from off Wata Mooli have not been found.

hexactis, Ophionereis H. L. Clark (1938, p. 324).
J6238, 2 paratypes, shore of East Point, Port Darwin, Northern Australia, June, 1929.

inanis, Ophiodaces Koehler (1922, p. 24, pl. LXXVIII, figs. 6-8, LXXXIII, fig. 7).
J3588, 2 syntypes, 66°8'S, 94°17'E, 216 m, January 27, 1914.

incipiens, Ophioceres Koehler (1922, p. 48, pl. LXXXIV, figs. 1-6, 13-14).
J3509, 11 syntypes, 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3838, 61 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3839, 76 syntypes, 64°32'S, 97°20'E, 198 m, January 31, 1914.
J3840, 3 syntypes, 60°32'S, 141°39'E, 271 m, December 31, 1913.
Note: The number of specimens recorded under J3509, J3838 and J3839 vastly exceeds the number recorded by Koehler (1922, p. 48). The discrepancy cannot be explained since the majority of these specimens have been destroyed. It appears, however, that not *all* the specimens recorded here can be considered as syntypes. Specimens numbered J3838, J3839 and J3840 destroyed in 1939. See note for *Leptoptychaster accrescens.*

irregularis, Amphiophiura Ziesenhenne (1940, p. 36, pl. 7, figs. 4-6).
J7401, paratype, off Minor Island, Galapagos Islands, dredged 126-144 m, January 20, 1938 ("Velero" stn. 792-38).

irregularis, Ophiotrichoides H. L. Clark (1938, p. 308, fig. 25).
J6042, holotype, Port Curtis, Queensland.
=*Ophiothrix (Keystonea) irregularis* (Clark) — see A. M. Clark and F. W. E. Rowe, 1971, p. 106.

laevis, Amphichondrius Ziesenhenne (1940, p. 22, pl. 4, figs. 7-9).
J7402, paratype, Tenacatita Bay, Mexico, dredged, 3-14 m, May 8, 1939 ("Velero" stn. 964-39).

laevis, Ophiactis H. L. Clark (1938, p. 268).
J6229, 3 paratypes, Koombana Bay, Bunbury, Western Australia, 9-14 m, October 26, 1929.

lampra, Macrophiothrix H. L. Clark (1938, p. 296, fig. 21).
J6221, paratype, Long Reef, Collaroy, New South Wales, November 28, 1929.

leucaspis, Amphiura H. L. Clark (1938, p. 226).
J6249, paratype, Broome, Western Australia, June, 1932.

lineata, Ophiogymna H. L. Clark (1938, p. 320).
J6045, holotype, west of Low Isles, Great Barrier Reef, Queensland, 10-14 m, mud and alcyonarians, November 15, 1928.
J6324, 2 paratypes, same locality data as J6045.

lutea, Ophiactis savignyi H. L. Clark (1938, p. 262).
J6236, paratype, Quail Island, near Darwin, Northern Territory, tidal pool, July 9, 1929.

magnisquama, Amphiura H. L. Clark (1938, p. 227).
J3504, holotype, 2.5-4 miles off Botany Bay, New South Wales, 59-100 m, trawled.
J6333, 2 paratypes, same locality data as J3504.
J6347, 2 paratypes, off Botany Bay, New South Wales, 90-92 m.

megacantha, Ophiarachna H. L. Clark, (1938, p. 341, figs. 28-30).
J6043, holotype, 25 miles south-east of Double Island Point, Queensland, 41 m.
J6379, paratype, same locality data as J6043.

microphylax, Ophiomitra H. L. Clark (1911, p. 184, fig. 84).
J2735, paratype, Kagoshima Gulf, Japan.

minuta, Amphistigma H. L. Clark (1938, p. 245, fig. 16).
J6282, 3 paratypes, Lord Howe Island, lagoon, 5-7 m.
=*Ophiostigma minuta* (Clark) — see Fell, 1960, p. 22.

monolepis, Ophiocoma scolopendrina H. L. Clark (1926, p. 187).
J4618, holotype, south-western coast of Ysabel Island, British Solomon Islands, August, 1924.

mordax, Ophiurolepis Koehler (1922, p. 71, pl. LXXXVIII, figs. 11-17).
J3606, syntype, 66°8′S, 94°17′E, 216 m, January 27, 1914.
J3608, syntype, 65°6′S, 96°13′E, 585 m, January 29, 1914.
J3607, syntype, 63°13½′S, 101°42′E, 1566 m, January 14, 1914.

multiremula, Amphiura H. L. Clark (1938, p. 228).
J6337, paratype, Long Reef, Collaroy, New South Wales, November 28, 1929.

nannodes, Amphiura H. L. Clark (1938, p. 230).
J6287, 2 paratypes, Bathurst Point, Rottnest Island, Western Australia, 1931.

occidentalis, Ophiocoma H. L. Clark (1938, p. 334, pl. 25, fig. 1).
J6216, 3 paratypes, Point Peron, Western Australia, 1929.

ophiactoides, Ophiophragmus Ziesenhenne (1940, p. 18, pl. 3, figs. 5-7).
J7350, 2 paratypes, Salinas Bay, Costa Rica, shore collection, February 10, 1935 ("Velero" stn. 474-35).

paucigranula, Ophiarachnella H. L. Clark (1938, p. 351, figs. 31a-31b).
J6044, holotype, north of North Direction Island, Queensland, 34 m (Great Barrier Reef Exped. "Magneta" stn. 17).

perplexa, Ophionereis Ziesenhenne (1940, p. 30, pl. 7, figs. 7-9).
J7353, paratype, Black Beach, Charles Island, Galapagos Islands, shore collection, December 14, 1934 ("Velero" stn. 351-35).

phanerum, Ophiocreas H. L. Clark (1916, p. 79, pl. 33, figs. 1-2).
E6297, holotype, 20 miles off Cape Barren, Cape Barren Island, Tasmania, 126 m.
E2267, 3 paratypes, locality same as E6297.
J2727, paratype, locality same as E6297.
E4726, paratype, Eastern Slope, Bass Strait, 126-180 m.
J2358, 2 paratypes, 8 miles east of Sandon Bluffs, New South Wales, 63-72 m.
E4692, paratype, east of Flinder's Island, Bass Strait, 144-540 m. (4 paratypes in M.C.Z.)
Note: Fourteen specimens were recorded by H. L. Clark (1916), one has not been found.

phragma, Ophiacantha Ziesenhenne (1940, p. 11, pl. 2, figs. 4-6).
J7397, paratype, north-east of Anacapa Island, California, U.S.A., dredged, 90 m, August 1, 1938 ("Velero" stn. 875-38).

phrixa, Amphiura H. L. Clark (1938, p. 323).
J6234, 4 paratypes, Roebuck Bay, Broome, Western Australia, sandy mud, August, 1929.

plateia, Ophiolepis Ziesenhenne (1940, p. 41, pl. 8, figs. 4-6).
J7348, 2 paratypes, Tenacatita Bay, Mexico, February 15, 1935, dredged in 10 m ("Velero" stn. 483-35).

proposita, Amphiura Koehler (1922, p. 27, pl. LXXXIX, figs. 8-12).
J3589 (part), 5 syntypes, 66°32′S, 141°39′E, 271 m, December 31, 1913.
J3589 (part), 1 syntype, 66°8′S, 94°17′E, 216 m, January 27, 1914.

ptena, Amphiura H. L. Clark (1938, p. 233, fig. 15).
J6283, paratype, Bunkers Bay, Western Australia, January 1930.

pulchellum, Pectinura cinctum H. L. Clark (1938, p. 339).
J6250, paratype, Broome, Western Australia, 1932.
=*Ophioconis cincta pulchella* (Clark) — see A. M. Clark and F. W. E. Rowe, 1971, p. 127.

pustulatum, Astrodendrum H. L. Clark (1916, p. 84, pl. 34, figs. 1-2).
E4700, holotype, east of Flinder's Island, Tasmania, 180-540 m.
=*Gorgonocephalus pustulatum* (Clark) — see Baker, 1974, p. 252.

relegata, Ophiura Koehler (1922, p. 57, pl. LXXXVIII, figs. 1-7).
J3505, 6 syntypes, 66°8'S, 94°17'E, 216 m, January 27, 1914.
J3817, 5 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
J3506, 5 syntypes, 65°42'S, 92°10'E, 108 m, January 21, 1914.
=*Theodoria relegata* (Koehler) — see Fell, 1961, p. 56.
Note: Seven specimens were originally registered under J3505, but one was sent to Dr. Mortensen. This leaves 6, but the report says 4. Also, Koehler records 12 specimens from Stn. 7 but the total for J3506 and J3817 is only 10.

rotundata, Ophiosteira Koehler (1922, p. 44, pl. LXXXIII, figs. 9-13).
J3566, holotype, 65°20'S, 95°27'E, 432 m, January 28, 1914.
J3856, paratype, 65°20'S, 95°27'E, 432 m, January 28, 1914.

rugosa, Ophiarachnella H. L. Clark (1938, p. 352, figs. 32-34).
J6210, paratype, Broome, Western Australia, June 1932.
=*Ophiarachnella sphenisci* (Bell) — see A. M. Clark and F. W. E. Rowe, 1971, p. 175.

rugosus, Astrothamnus H. L. Clark (1916, p. 85, pl. 35, figs. 1-2).
E4965, holotype, east of Flinders Island, Tasmania, 144-540 m.
E4733, paratype, south-east of Cape Everard, Victoria, 360 m.
E4732, paratype, locality same as E4733. (3 paratypes in M.C.Z.)
Note: Both of the specimens E4965 and E4733 are accompanied by hand-written labels of H. L. Clark, designating them as "Holotype" and "Paratype" respectively. The third specimen, E4732, is without original label but assigned "Paratype" in the departmental Accessions Register. Of the 3 specimens, from Flinders Island, reported in the M.C.Z. collections (Downey, 1968) only 1 can be found according to Dr. D. Opresko (pers. comm.) and this has an original "Paratype" label with it. Clark (1916) referred to only 4 specimens in his report, of which he refers to "The *specimens* from off Cape Everard . . .", indicating that at least 2, if not 3 of the 4 specimens were from that locality. Even if Clark described more than the 4 specimens recorded in his report (1916), it is difficult to equate as paratypes all 3 specimens in the M.C.Z. from the holotype locality, i.e. Flinders Island. It could be, however, that the M.C.Z. only ever possessed 1 paratype, and providing that The Australian Museum specimen E4732 is considered a valid paratype, then 2 specimens could have been collected from each of the two localities listed by Clark and the 4 specimens reported by him accounted for.

rugosus, Astrothrombus H. L. Clark (1909, p. 548, pl. 44, fig. 3).
J871, holotype, off Wollongong, New South Wales, 99-100 m, sand and mud to rock.

scotia, Macrophiothrix H. L. Clark (1938, p. 3000, pl. 24, fig. 2).
J6226, 3 paratypes, Entrance and Gautheaume Points, Broome, Western Australia, 1929.

sculptilis, Amphiodia Ziesenhenne (1940, p. 24, pl. 5, figs. 1-3).
J7396, paratype, Chacahua Bay, Mexico, dredged 7-21 m, March 22, 1939 ("Velero" stn. 927-39).

semperi, Ophiopsammium Lyman (1874, p. 232, pl. 4, figs. 11-17).
J2742, paratype, Philippine Islands, 18 m.

sollicita, Ophiacantha Koehler (1922, p. 14, pl. LXXIX, figs. 1-3).
J3557, 2 syntypes, Maria Island, Tasmania, 2340 m, December, 1912.

spinifera, Macrophiothrix H. L. Clark (1938, p. 302, pl. 24, fig. 3).
J6222, 3 paratypes, Broome, Western Australia, 1929, 1932.

stellatus, Ophiophragmus Ziesenhenne (1940, p. 21, pl. 6, figs. 6-9).
J7398, paratype, San Juan Bay, Peru, dredged, 54-72 m, February 7, 1938 ("Velero" stn. 823-38).

stenaspis, Amphioplus H. L. Clark (1938, p. 254, figs. 18-19).
J6245, 2 paratypes, little below low water mark, 3½ Mile Reef, Port Darwin, Northern Territory, June 24, 1929.

stictantha, Amphiura H. L. Clark (1938, p. 234).
J6252, 2 paratypes, Broome, Western Australia, 9-12 m, 1932.

stigma, Ophionereis H. L. Clark (1938, p. 234).
J6230, 3 paratypes, Broome, Western Australia, August and September, 1929.

symbiota, Ophiactis H. L. Clark (1916, p. 88, pl. 36).
E6296, holotype, east of Flinders Island, Bass Strait, 180-540 m, commensal on disc of *Comanthus plectrophorum* (crinoidea), February 18, 1916.

tenuis, Ophionephthys H. L. Clark (1938, p. 241).
J6231, 3 paratypes, on mud flats near jetty at Broome, Western Australia, muddy sand, August-September, 1929.
=*Amphiura (Ophiopeltis) tenuis* (Clark) — see A. M. Clark and F. W. E. Rowe, 1971, p. 175.

tenuispina, Ophiacantha H. L. Clark (1938, p. 210).
J6049, holotype, off Gatecombe Head, Port Curtis, Queensland, 16-21 m, 1929.

tigris, Ophionereis H. L. Clark (1938, p. 327, pl. 25, fig. 6).
J6050, holotype, Norwest Island, Capricorn Group, Queensland, 1930.

tumescens, Ophiurolepis Koehler (1922, p. 64, pl. LXXXVII, figs. 6-8, 10-14).
J3580, 2 syntypes (specimens C and D), 65°6'S, 96°13'E, 585 m, January 29, 1914.
J8452, 2 syntypes (specimens A and B), 66°32'S, 141°39'E, 271 m; 65°20'S, 95°27'E, 432 m, December-January, 1913-14.

tylota, Ophiolebes H. L. Clark (1911, p. 243, fig. 117).
J2748, paratype, Bering Sea.

unicolor, Ophiolepis H. L. Clark (1938, p. 364, pl. 25, fig. 2).
J6312, paratype, Entrance and Gautheaume Points, Broome, Western Australia, 1929.

ECHINOIDEA

apicatus, Hemiaster (Rhinobrissus) Tenison-Woods (1880, p. 282, pl. 13).
G10939, 4 syntypes, Port Jackson, New South Wales.
=*Rhinobrissus hemiasteroides* (A. Agassiz) — see Mortensen, 1951, p. 490.

atropurpurea, Stomopneustes Tenison-Woods (1881, p. 198).
J535, holotype, north-east Australia.
=*Stomopneustes variolaris* (Lamarck) — see Mortensen, 1935, p. 512.

aurorae, Pourtalesia Koehler (1926, p. 43, pls. CV, figs. 1-8; CXXI, fig. 3).
J4913, syntype (specimen B, C or D), 65°20'S, 95°27'E, 432 m, January 28, 1914 or 65°6'S, 96°13'E, 585 m, January 29, 1914.
J4912, syntype (specimen B, C or D), 63°13'S, 101°42'E, 1566 m, January 14, 1914.
J4843, syntype (specimen A), 65°20'S, 95°27'E, 432 m, January 28, 1914.

australe, Echinosoma Koehler (1926, p. 38, pls. CVII, figs. 1-2; CVIII, figs. 1-2; CIX, figs. 9-10; CXXI, fig. 2).
J4834, holotype, 35°44'S, 135°58'E, 3240 m, February 25, 1914.
=*Tromikosoma australe* (Koehler) — see Mortensen, 1935, p. 177.

australiae, Evechinus Tenison-Woods (1878, p. 167).
J1099, 3 syntypes, Port Jackson, New South Wales.
=*Tripneustes gratilla* (Linnaeus) — see Mortensen, 1943, p. 298.

australis, Coelopleurus H. L. Clark (1916, p. 107, pl. 43, figs. 1-2).
E5296, holotype, Eastern Slope, Bass Strait, 108-201 m.

australis, Phyllacanthus Ramsay (1885, p. 44, pl. 1).
J193, syntype, Port Jackson, New South Wales, dredged near South Reef, 10 m.
=*Prionocidaris australis* (Ramsay) — see H. L. Clark, 1916, p. 97.

bajulus, Pachycentrotus Dartnall (1972, p. 30, figs. 1-3).
J7801, 3 paratypes, Eaglehawk Neck, Tasmania, February, 1948, collected V. V. Hickman.
J6393, paratype, locality same as J7801, January 27, 1928.

brevisternalis, Antipneustes Koehler (1926, p. 83, pls. CXII, figs. 2-6; CXXIV, fig. 3).
J4819, holotype, 65°48'S, 137°32'E, 414 m, January 2, 1914.
=*Amphipneustes brevisternalis* (Koehler) — see Mortensen, 1951, p. 269.

cavernosa, Temnopleurus Tenison-Woods (1880a, p. 493, pl. 15, figs. 3-4).
G7101, holotype, Port Denison, Queensland.
=*Temnotrema bothryoides* (L. Agassiz) — see Mortensen, 1943, p. 254.

conferta, Cidaris H. L. Clark (1916, p. 100, pl. 38, figs. 1-4).
E4685, holotype, Eastern Slope, Bass Strait, 144-360 m.
E4740, paratype, south of Gabo Island, Victoria, about 360 m.
E4741, paratype, same locality data as E4740.
=*Stylocidaris conferta* (Clark) — see Mortensen, 1928, p. 351. (2 paratypes in M.C.Z.) M.C.Z.)

contracta, Notocidaris platyacantha Koehler (1926, p. 13, pls. XCIV, fig. 5; XCVI, figs. 1-6; CXIX, fig. 5).
J4835, syntype (specimen A), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J4837, syntype (specimen B), locality same as J4835.
J4839, syntype (specimen C), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4836, syntype (specimen D), locality same as J4839.
J4838, syntype (specimen E), locality same as J4839.
J4867, Mounted spines, locality uncertain. Figured in Koehler's Report, 1926, pl. XCVI, figs. 5-6.

darnleyensis, Echinus Tenison-Woods (1878, p. 165).
J1297, 5 syntypes, Cape Grenville and Darnley Island, Torres Strait, North Queensland, sand mud, 18-36 m.
=*Nudechinus darnleyensis* (Tenison-Woods) — see H. L. Clark, 1912, p. 277.

debilis, Pourtalesia Koehler (1926, p. 49, pls. CV, fig. 9; CVI, fig. 1-10; CXXII, fig. 1).

J4810, syntype, 64°44'S, 97°28'E, 644 m, January 31, 1914.
J4905, 2 syntypes, 64°44'S, 97°28'E, 644 m, January 31, 1914.

dentifer, Sterechinus Koehler (1926, p. 34, pls. CIV, figs. 1-4; CXX, fig. 1).
J4898, holotype, 63°13'S, 101°42'E, 1566 m, January 14, 1914.

dolosus, Hypselaster H. L. Clark (1938, p. 430, pl. 28, figs. 4-7).
J6162, paratype, Broome, Western Australia, flat near jetty, September 1929.

flemingi, Pseudechinus Fell (1958, p. 36, pl. 3, fig. A, pl. 5, fig. A).
J7113, paratype, off Chatham Islands, New Zealand, 725 m.

impressa, Goniocidaris Koehler (1926, p. 24, pl. XCI, figs. 1-8, XCII, figs. 1-5, 8-14; CXIX, fig. 1).
J4849, holotype (fig'd specimen), off Maria Island, 117 m, December 12, 1912.
J4907, 9 paratypes, off Maria Island, 117 m, December 12, 1912.
J4908, 5 paratypes, off Maria Island, 117 m, December 12, 1912.

ingens, Abatus Koehler (1926, p. 58, pl. CXI, fig. 9; CXIII, fig. 7; CXVII, figs. 3-5, 7-8; CXVIII, figs. 1-7; CXXIII, figs. a-k).
J4874, syntype (specimen C), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4869, syntype (specimen A), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4870, syntype (specimen B), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4868, syntype (specimen D), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4872, syntype (specimen F), 64°32'S, 97°20'E, 198 m, January 31, 1914.
Note: Specimen J4872 sent as exchange to Mortensen.

isolatus, Clypeaster Serafy (1971, p. 166, figs. 1A-E, 2, 3, table 1).
J7793, 4 paratypes, off San Felix Island, Chile, 75 m.

maculosa, Stylocidaris Mortensen (1928a, p. 72).
J5156, paratype, Sagami Sea, Japan, 100-200 m, June, 1914.

marsupialis, Antipneustes Koehler (1926, p. 79, pls. CXV, figs. 2, 5, 7-9; CXXIV, fig. 2).
J4816, holotype (specimen A), 66°55'S, 145°21'E, 572 m, December 28, 1913.
J4818, paratype (specimen B), 66°55'S, 145°21'E, 572 m, December 28, 1913.
=*Amphipneustes marsupialis* (Koehler) — see Mortensen 1951, p. 268.

notium, Temnotrema H. L. Clark (1938, p. 387, pl. 26, fig. 5).
J3977, holotype, King George's Sound, Albany, Western Australia, collected E. le G. Troughton.
=*Temnopleurus (Toreumatica) michaelseni* (Döderlein) — see Mortensen, 1943, p. 105.

notius, Parechinus H. L. Clark (1916, p. 111, pl. 41, figs. 1-3).
E5289, holotype, south of Gabo Island to the south-east of Victoria, 125-144 m.
=*Pseudechinus notius* (Clark) — see Mortensen, 1921, p. 167.

nutriens, Fibularia H. L. Clark (1909, p. 557, pl. 58, figs. 1-11).
J843, 2 syntypes, off Cape Three Points, New South Wales, 73-90 m, sticky mud and shell (no longer recognisable as specimens).
J844, 40 syntypes, same locality data as J843.
J842, 2 syntypes, off Wata Mooli, New South Wales, 97-106 m (missing from container, June, 1974). (22 syntypes in M.C.Z.)
Note: Of the 87 specimens recorded by Clark, 22 from off Cape Three Points are housed as syntypes in the Museum of Comparative Zoology, Harvard, U.S.A. (Downey, 1968). Of the remaining 63 specimens recorded from Cape Three Points, only 40 are now recorded under number J844 in the Australian Museum collection. The Departmental register records 62 specimens under J844, of which 6 were sent to the Smithsonian

Museum in 1965 and 6 to Stockholm in 1921. It is not possible to account for the difference of 11 specimens.

oligopora, Salmacis H. L. Clark (1916, p. 113, pl. 42, figs. 1-1, pl. 43, fig. 2).
E641, holotype, Oyster Bay, Tasmania, 36-72.
E1622, 2 paratypes, 6 miles east of Cape Hawke, New South Wales, 84-90 m (a label with these specimens, in H. L. Clark's handwriting, notes "8 paratypes" but only 2 specimens are noted in the Departmental register).
E1652, 4 paratypes, 8 miles east of Sandon Bluff, New South Wales, 63-72 m (a label with these specimens, in H. L. Clark's handwriting, notes "4 paratypes, alc.", suggesting that these specimens were originally preserved in alcohol. The Departmental register notes 7 specimens for this number, but this has been altered to 4).
=*Salmaciella oligopora* (Clark) — see Mortensen, 1943, p. 146. (4 paratypes in M.C.Z.) M.C.Z.)
Note: H. L. Clark (1916) records only 8 specimens, though his text indicates that he examined 9 specimens (including 2 atypical ones). The total number of specimens collected by "Endeavour" and examined by Clark is therefore uncertain, particularly in view of his labels which accompany The Australian Museum specimens. The specimen E641 is clearly documented as the holotype. The paratype specimens E1652 and E1622 bear Clark's labels and can be presumed to be such. A further 5 specimens (numbers J2121-2125 and J2155) do not have Clark labels with them though 2 of them (J2121 and J2122) are referred to by Clark (1916) as being atypical or deformed. Of the 4 specimens in the M.C.Z., one has an Australian Museum Accessions number, J2156, one is accompanied by two numbers, J2120 and J2126, and the other two do not have Australian Museum numbers with them. Each specimen, however, is accompanied by an H. L. Clark label notating as a "Co-type". It is impossible to determine the value of the status of each of the type-specimens with the exception of the holotype.

parvispina, Phyllacanthus Tenison-Woods (1880, p. 286, pl. 14).
J186, syntype, Port Jackson, New South Wales.

peloria, Maretia H. L. Clark (1916, p. 121, pl. 44, figs. 1-3).
E6304, holotype, 26 miles SW of Cape Everard, Victoria (fragmented).
E2271, paratype, locality same as E6304 (fragmented).
=*Paramaretia peloria* (Clark) — see Mortensen, 1951, p. 46. (1 paratype in M.C.Z.)

phoenissa, Temnotrema H. L. Clark (1926, p. 188, fig. 1).
J4644, holotype, Ellison Reef, Great Barrier Reef, Queensland, 14 m.

planissimus, Echinocyamus H. L. Clark (1938, p. 422, pl. 27, figs. 5-8).
J6160, paratype, Pearl Shoal, Broome, Western Australia, 9-12 m, broken shell, September 26, 1929.

regalis, Cyclaster Baker (1969, p. 266, text-figs. 1-8, pl. 1).
J7800, 3 paratypes, between Mayor Island and Cuvier Island, New Zealand, 207-468 m.

rostratus, Antipneustes Koehler (1926, p. 70, pl. CXIV, figs. 1-6; CXV, figs. 1, 3, 4, 6; CXVI, figs. 1-6; CXVII, figs. 1, 2, 6, 9; CXXIV, fig. 1).
J4832, syntype (specimen H), 60°32'S, 141°39'E, 282 m, December 31, 1913, or 64°44'S, 97°28'E, 644 m, January 31, 1914.
J4830, syntype (specimen E), locality data same as J4832.
J4831, syntype (specimen F), locality data same as J4832.
J4833, syntype (specimen G), locality same as J4832.
J4821-4, 4 syntypes (specimens A, B, C and D), locality data same as J4832.
=*Amphipneustes rostratus* (Koehler) — see Mortensen 1951, p. 268.
Note: Specimens numbered J4831 and J4833 sent as exchange to Mortensen in 1927.

rugosa, Eurocidaris Koehler (1926, p. 17, pl. XCIX, figs. 4-9; C, figs. 1-6; CI, figs. 1-7; CII, figs. 1-7; CXIX, fig. 2).
J4863, syntype (specimen G), 65°6'S, 96°13'E, 585 m, January 29, 1914.
J4887, syntype (specimen A), 65°6'S, 96°13'E, 585 m, January 29, 1914, or 65°20'S, 95°27'E, 240 fathoms, January 28, 1914.
J4886, syntype (specimen D), locality same as J4863.
J4897, syntype (specimen J), 65°6'S, 96°13'E, 585 m, January 29, 1914.
J4884, syntype (specimen E), 65°20'S, 95°27'E, 432 m, January 28, 1914.
J4861, syntype (specimen B), locality same as J4863.
J4859, syntype (specimen C), locality same as J4863.
J4848, syntype (specimen F), locality same as J4863.
J4844, syntype (specimen H), locality same as J4863.
J4847, syntype (specimen I), locality same as J4863.
J4866, Mounted arm spines, locality uncertain. Figured in Koehler's Report, 1926, pl. XCIX, fig. 9.
=*Ctenocidaris rugosa* (Koehler) — see Mortensen 1928, p. 126.
Note: Specimens J4859, J4848 and J4844, were sent as an exchange to Mortensen in 1927.

spinosa, Notocidaris Koehler (1926, p. 14, pl. XCVIII, figs. 1-6; XCVIII, figs. 1-7; XCIX, figs. 1-3; CXII, fig. 7; CXIV, fig. 7; CXIX, fig. 6).
J4891, syntype (specimen E), 64°32'S, 97°20'E, 198 m, January 31, 1914.
J4890, syntype (specimen D), locality data same as J4891.
J4846, syntype (specimen A), locality same as J4891.
J4862, syntype (specimen B), locality same as J4891.
J4860, syntype (specimen C), locality same as J4891.
J4893, syntype (specimen F), locality same as J4891.
J4894, syntype (specimen G), locality same as J4891.
J4864, Mounted spines, locality same as J4891. Figured in Koehler's Report, 1926, pl. XCVII, figs. 5 and 6.
=*Ctenocidaris spinosa* (Koehler) — see Mortensen 1928, p. 124.

tuberculatum, Chaetodiadema H. L. Clark (1909, p. 554, pls. 61, 67).
G11429, syntype, off Wata Mooli, New South Wales, 93-127 m, soft mud. (1 syntype in M.C.Z.)

tumescens, Antipneustes Koehler (1926, p. 76, pl. CXIII, figs. 1-6).
J4820, holotype, 66°55'S, 145°21'E, 572 m, December 28, 1913.
=*Amphipneustes tumescens* (Koehler) — see Mortensen 1951, p. 267.

tumidus, Echinanthus Tenison-Woods (1878, p. 169).
J1348, holotype, New South Wales.
=*Clypeaster tumidus* (Tenison-Woods) — see Mortensen, 1948, p. 55.

woodsi, Salmacis Ramsay (1885, p. 47, pl. 2, figs. 1-3).
J879, holotype, off Port Jackson, New South Wales, 63 m.
=*Salmacis virgulata* (L. Agassiz) (deformed specimen) — see H. L. Clark, 1946, p. 311.

HOLOTHURIOIDEA

adhaerens, Psolidiella Hickman (1962, p. 50, text figs. 1-16, pl. 1, fig. 1).
J7227, microslide, anal teeth of syntype, Pirate's Bay, Eaglehawk Neck, Tasmania.
J7229, microslide, tentacles and calcareous ring of syntype, locality same as J7227, date unknown.
J7230, microslide, part of sole of syntype, locality same as J7227, May 13, 1954.
J7231, microslide, part of dorsum of syntype, locality same as J7227, May 13, 1954.

bisperforata, Protankyra H. L. Clark (1938, p. 553, fig. 62).
J6441, 2 paratypes, "Jetty Flat", Broome, Western Australia, low tide mark, 1929.
=*Rynkatorpa bisperforata* (Clark) — see Rowe and Pawson, 1967, p. 31.

delicata, Aphelodactyla H. L. Clark (1938, p. 542, fig. 59).
J4690, paratype, between Cape Jaubert and Wallal, Western Australia, muddy sand, 9-14 m, September, 1929.
=*Acaudina delicata* (Clark) — see H. L. Clark, 1946, p. 446.

dissimilis, Molpadia H. L. Clark (1909, p. 561, pl. 58, figs. 12-21).
J1013, syntype, "Thetis" Station 46, off Jibbon, New South Wales, 90-118 m, mud and abattoir refuse, 1898.
J1014, syntype, locality same as J1013. (1 syntype listed in the M.C.Z. catalogue cannot be found in the collection; Dr. D. Opresko, pers. comm.)

dyscrita, Leptosynapta H. L. Clark (1938, p. 551, fig. 61).
J6465, 2 paratypes, Roebuck Bay, Broome, Western Australia, sandy mud, low tide, 1929.

grisea, Thyone H. L. Clark (1938, p. 467, fig. 40).
J6461, 2 paratypes, False Cape Bossut, near Broome, Western Australia, 1929.

hickmani, Rynkatorpa Rowe and Pawson (1967, p. 32, figs. 1-15).
J7544, holotype, Derwent River Estuary, Hobart, Tasmania, dredged April 18, 1963.
J7545A, microslide, anterior skin of holotype.
J7545B, microslide, posterior skin of holotype.
J7546, microslide, radial muscle and tentacle of holotype.

lividus, Neoamphicyclus Hickman (1962, p. 58, pl. 1, fig. 5, text figs. 53-63).
J7217, microslide, peristomium of syntype, Pirate's Bay, Eaglehawk Neck, Tasmania, under stones at low tide.
J7218, microslide, outer tentacles of syntype, locality same as J7217.
J7220, microslide, skin of middle one-third of syntype, locality same as J7217.
J7221, microslide, skin of posterior one-third of syntype, locality same as J7217.
J7225, microslide, outer and inner tentacle of syntype, locality same as J7217.
J7196, 11 syntypes, locality same as J7217, March 7, 1960.

longipedes, Actinocucumis H. L. Clark (1938, p. 480, fig. 45).
J6452, 2 paratypes, False Cape Bossutt, near Broome, Western Australia, dredged, 1929.
=*Actinocucumis typicus* Ludwig — see Heding and Panning, 1954, p. 72.

luticola, Paracaudina Hickman (1962, p. 65, text figs. 131-139).
J7222, microslide, spicules from tail of syntype, Ralph's Bay, Derwent Estuary, Tasmania, 12 m, June 30, 1959.
J7223, microslide, anal papilla of syntype, locality same as J7222.
J7224, microslide, "Tail" of syntype, locality same as J7222.
J7205, 2 syntypes, "Tails" locality same as J7222.

macroperona, Holothuria H. L. Clark (1938, p. 535, fig. 57).
J6434, paratype, cove at north-west corner of Rottnest Island, Western Australia, October 19, 1929.
=*H. (Thymiosycia) macroperona* Clark — Rowe, 1969, p. 147.

magna, Chirodota H. L. Clark (1938, p. 556, fig. 63).
J5985, holotype, off Sow and Pigs Reef, Port Jackson, New South Wales, 10 m, dredged.

minuta, Thyone H. L. Clark (1938, p. 470, fig. 42).
J6466, 10 paratypes, Pearl Shoal, Broome, Western Australia, 1932.
=*Stolus minutus* (Clark) — see Panning, 1949, p. 462.

minutus, Psolus H. L. Clark (1938, p. 507, figs. 51, 52).
J6450, 3 paratypes, Neds Beach, Lord Howe Island, under surface of rock fragment near low water mark, April, 1932.

parvipedes, Phyllophorus H. L. Clark (1938, p. 489, fig. 47).
J6041, holotype, Broome, Western Australia, 1930.
=*P. (Phyllophorella) parvipedes* Clark — see Heding and Panning, 1954, p. 160.

productamensis, Molpadia H. L. Clark (1909, p. 562, pl. 58, figs. 22-30).
J1011, syntype, "Thetis" Station 46, off Jibbon, New South Wales, 90-118 m, mud and abattoir refuse, 1898. (3 syntypes in M.C.Z.)
Note: H. L. Clark (1909) records only 3 specimens. It could be that one of the M.C.Z. specimens represents the closely allied species *M. dissimilis* which has been placed with 2 specimens of *M. productimensis.* This would account for the specimen of *M. dissimilis* missing from the M.C.Z. collections (see also p. 360).

ravum, Psolidum Hickman (1962, p. 60, text figs. 75-86, pl. 2, fig. 7).
J7232, microslide, tentacles of syntype, Blackman's Bay, Derwent Estuary, Tasmania, under stone at low tide, January 27, 1956, coll. V. V. Hickman.
J7233, microslide, introvert of syntype, locality same as J7232.
J7234, microslide, part of dorsum of syntype, locality same as J7232.
J7235, microslide, part of wole of syntype, locality same as J7232.
J7202, syntype, Ralph's Bay, Derwent Estuary, Tasmania, August 28, 1959, about 12 m

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ANNOTATED CHECKLIST OF THE FISHES OF LORD HOWE ISLAND

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SUMMARY

Lord Howe Island, some 630 kilometres off the northern coast of New South Wales, Australia at 31.5° South latitude, is the world's southernmost locality with a well developed coral reef community and associated lagoon. An extensive collection of fishes from Lord Howe Island was made during a month's expedition in February 1973. A total of 208 species are newly recorded from Lord Howe Island and 23 species newly recorded from the Australian mainland. The fish fauna of Lord Howe is increased to 447 species in 107 families. Of the 390 species of inshore fishes, the majority (60%) are wide-ranging tropical forms; some 10% are found only at Lord Howe Island, southern Australia and/or New Zealand. Less than 4% of the shore fishes are endemic to the Lord Howe region (including Norfolk Island). Some 32% of the inshore species are restricted to the south-western or southern Pacific Ocean.

INTRODUCTION

Lord Howe Island (31°32'S, 159°04'E), which lies some 630 kilometres off the coast of northern New South Wales (Fig. 1), is of special interest to marine biologists because of its geographic position. Sparse coral growth may be present at other areas farther south, but Lord Howe Island is the world's southernmost locality exhibiting a well developed barrier coral reef community and associated lagoon. The inshore fish fauna of the island is particularly interesting as it is composed of a combination of tropical and temperate forms. The present paper includes a list of the fishes reported from Lord Howe Island prior to 1973 and 39 unreported records based on specimens at the Australian Museum, Sydney. In addition, 169 new records are reported of which specimens were taken or individuals positively observed during February 1973 by a team of ichthyologists from The Australian Museum and Bishop Museum, and financed by the National Geographic Society, Washington, D.C. and the Trustees of The Australian Museum. Also, Allen (in press) has recorded 28 new records based on material collected by the expedition.

1 The Australian Museum, Sydney.

2 Present address: Western Australian Museum, Perth.

3 Bernice P. Bishop Museum, Honolulu.

4 Present addresses: Macquarie University, North Ryde.

5 Deceased.

Records of The Australian Museum, 1976, **30**, 365-454, Figures 1-2.

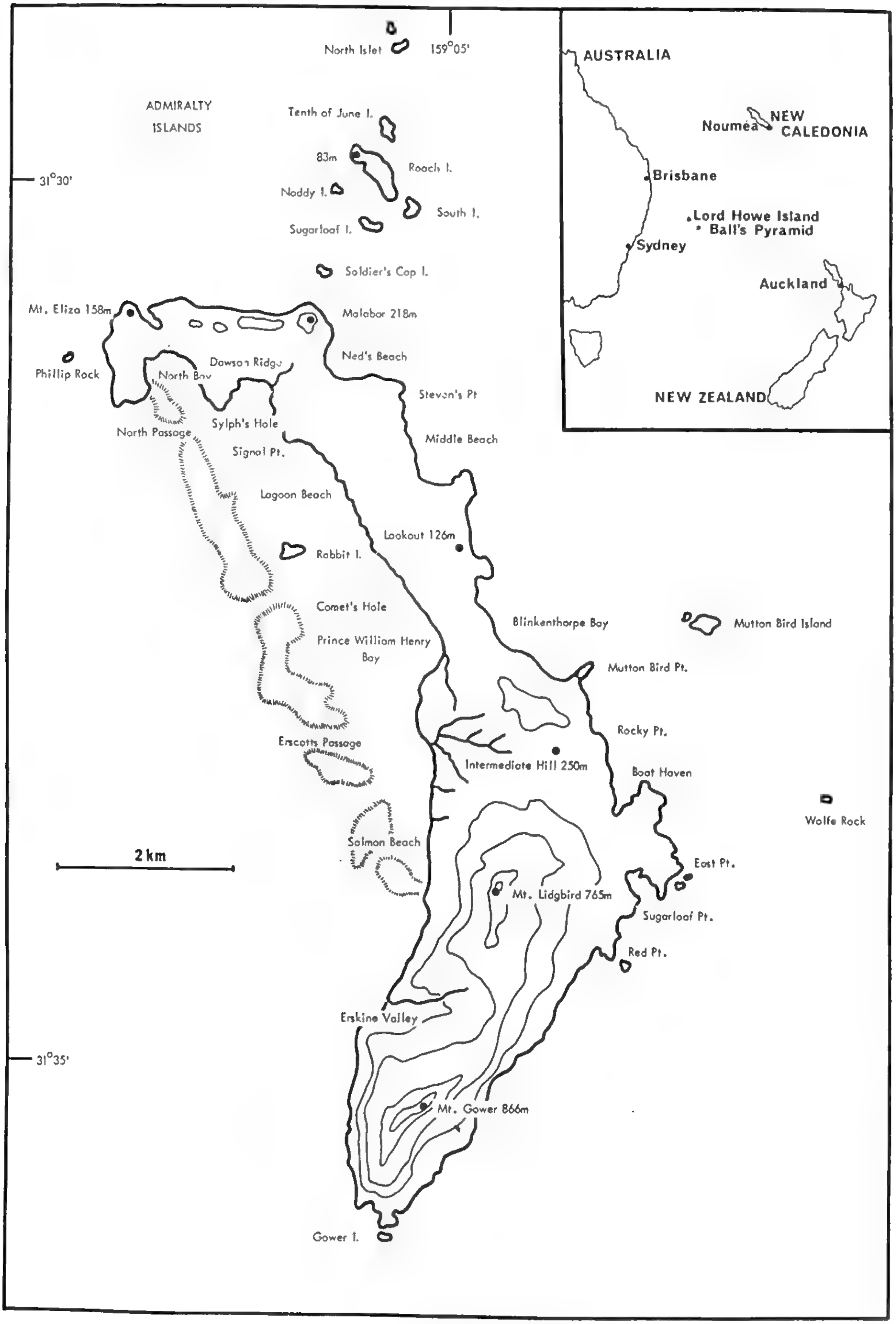

Fig. 1. Lord Howe Island.

Over 6,000 specimens belonging to 77 families and 295 species were procured during the month-long expedition; 24 species were recorded on the basis of underwater observations and photographs. A total of 99 collections was made employing a variety of methods. The most important involved the use of SCUBA with spears, rotenone, and explosives. Forty-five collections were made with spears and/or quinaldine anaesthetic. Rotenone was utilized for 17 stations, and explosives (2 pound charges of gelignite) for 10 quantitative collections. Other methods were as follows: nightlight and dipnet — 8 stations; beach strandings — 7; hook and line — 5; gill net — 4; seine — 2; and trap — 1. SCUBA diving collections covered all depths down to 50 metres. Thirty-nine of the total collections were made inside the lagoon, 12 along the outer face of the lagoon reef, 23 along rocky and coral coastal areas, and 25 in other areas, generally offshore. As a result of our collecting efforts, there are now 447 species and 107 families of fishes known from Lord Howe Island

HISTORICAL REVIEW

Lord Howe Island was first visited by Europeans in 1788. On landing in March, 1788, Blackburn noted "The bay abounds with a variety of Excellent Fish" (Rabone, 1940). There is no evidence that the island was previously inhabited by man. Various notes and paintings of Lord Howe Island fishes, usually together with those from Norfolk Island, were made by colonists and visitors between 1788 and 1840.

The first collection of Lord Howe fishes was made by the naturalists aboard HMS "Herald" in 1853. The first scientific record is apparently that of *Serranus ouatalibi* (=*Cephalopholis sexmaculatus*) by Günther in 1859.

The Australian Museum has been closely associated with the study of the natural history of Lord Howe Island for more than 120 years. John MacGillivray collected there in 1853. The first fishes from Lord Howe Island noted in the Australian Museum registers were purchased from Captain J. Armstrong in 1881 (AMS A. 10,000-10,017). Ramsay and Ogilby (1882) provided the first Australian ichthyologists' report on the island with their description of *Coris semicincta* (=*C. picta*). The first museum expedition to collect fishes was conducted by R. Etheridge and party in 1887, and formed part of the basis for the first catalogue of Lord Howe Island fishes by Ogilby (1889). This list included 88 species. Collections by Waite in 1898 and Waite and McCulloch in 1902, as well as donations by the islanders and visitors, resulted in a series of papers entitled "Additions to the fish fauna of Lord Howe Island" and culminated in Waite's 1904 Catalogue of the Fishes of Lord Howe Island. This list included 180 species.

McCulloch made a number of trips to Lord Howe (his ashes repose in a monument on the island). Additions to the total number are also the result of Whitley's trip in 1939, as well as numerous donations through the years from the islanders. Their continued interest has resulted in many of the deep water species listed, as these are picked up on the beaches after storms. The additions by McCulloch, Whitley, and others (see the bibliography) have brought the total of known Lord Howe Island fishes to 208 by the end of 1972.

Most of the fishes collected from Lord Howe Island are in the Australian Museum. A number of species reported by Ogilby are based on specimens now in the Queensland Museum and once in the collection of the Amateur Fisherman's Association of Queensland. The British Museum (Natural History) has some early collections, as well as a collection purchased in 1926. Most of the present collection has been registered in the Australian Museum, with a representative collection in the Bernice P. Bishop Museum. Duplicates of the commonest species will be sent to the National Museum, Wellington, New Zealand; Queensland Museum, Brisbane; California Academy of Sciences, San Francisco; British Museum (Natural History), London; U.S. National Natural History Museum, Washington, D.C.; and Los Angeles County Museum of Natural History.

PHYSICAL FEATURES OF LORD HOWE ISLAND

Lord Howe Island is of volcanic origin and consists of a narrow strip of land extending for about eleven kilometres in a general north-south direction (see map, Fig. 1). The island is mostly covered with lush vegetation which is reminiscent of more tropical localities. The most conspicuous topographical features are the twin peaks of Mt. Lidgbird (765 m) and Mt. Gower (866 m), which occupy much of the southern portion of the island and rise abruptly from the sea. They form a spectacular backdrop to the lagoon which is situated on the leeward or western side of the island. The lagoon is approximately 6 kilometres in length and 1½ kilometres across at its widest point. It is mostly shallow (average depth about 1 metre) and consists largely of sandy bottom, but at several areas, including Sylph's Hole and Comet's Hole, depths to 8 metres rich with living coral are encountered. The lagoon barrier reef is pierced by Erscott's Passage to the south and North Pass, the latter constituting the main entrance, with a depth of 4 to 6 metres and easily negotiated by small boats. Outside the lagoon the shoreline drops off steeply to depths of 15 to 20 m and then gradually slopes to deeper water. The 200 metre contour is generally located 7 to 12 kilometres off-shore. There are several small rocky islets around the periphery of Lord Howe Island. The most noteworthy are in the Admiralty Group, which comprises 7 islets, the closest of which is situated 1½ kilometres off the north-east tip of Lord Howe Island. Ball's Pyramid is a monolithic spire which rises to an elevation of 549 m and is located about 30 kilometres south-west of the main island. It is about 1 kilometre long by ½ kilometre wide. The Pyramid is inhabited by a large population of sea birds, as are the Admiralty Islets.

UNDERSEA ENVIRONMENT

Lord Howe Island is located near the middle of an oval-shaped submerged platform (9 × 18 kilometres) with general depths of 30 to 60 metres. The bottom is rocky with deposits of calcareous sand in depressions. Fine sediments occur only in the deeper parts of the lagoon. Most of the shoreline is steep with depths of 10 to 20 metres or more immediately adjacent to shore except along the lagoon. The near-shore habitat consists mostly of highly evolved volcanic rock. Caves, ledges, fissures and archways are common features. Reef-building corals are common but exist as scattered isolated colonies and not as massive reefs. Only in restricted areas around the edge of deeper lagoon holes and parts of the western reef edge can coral growth be called profuse, but here it forms the facies of a typical tropical reef with great structural diversity. Sandy beaches occur along the lagoon shore and in three limited sections along the eastern side of the island.

As would be expected from an island at 31°32'S, there are not many coral species (Veron, 1975); temperatures are probably limiting. No systematic water temperatures have been measured at Lord Howe Island. On the basis of oceanic sea surface temperatures, the waters around Lord Howe vary from summer averages of 23°C to winter averages of 18-19°C; these data are taken from monthly maps of surface isotherms (Anonymous, 1945). Sea surface temperatures within 30 miles of Lord Howe Island (31.2-31.8°S, 158.7-159.3°E) were extracted from computerised station data of the World Oceanographic Data Center in Washington; a total of 68 stations, taken from 1935 to 1972, were within the grid. Plots of monthly extremes and means (Fig. 2) clearly indicate the seasonal differences in temperature, although the extremes of any given month are probably greater than the relatively meagre data show. Shallow waters of the lagoon exceed the above extremes, as McCulloch records temperatures varying from 21° to 27.5°C in December, 1902 in his manuscript diary. The available data do not allow an analysis of annual variations in temperature extremes, but fluctuations in the complex East Australian Current, which affects the waters around Lord Howe Island, are indicated (Highley, 1967).

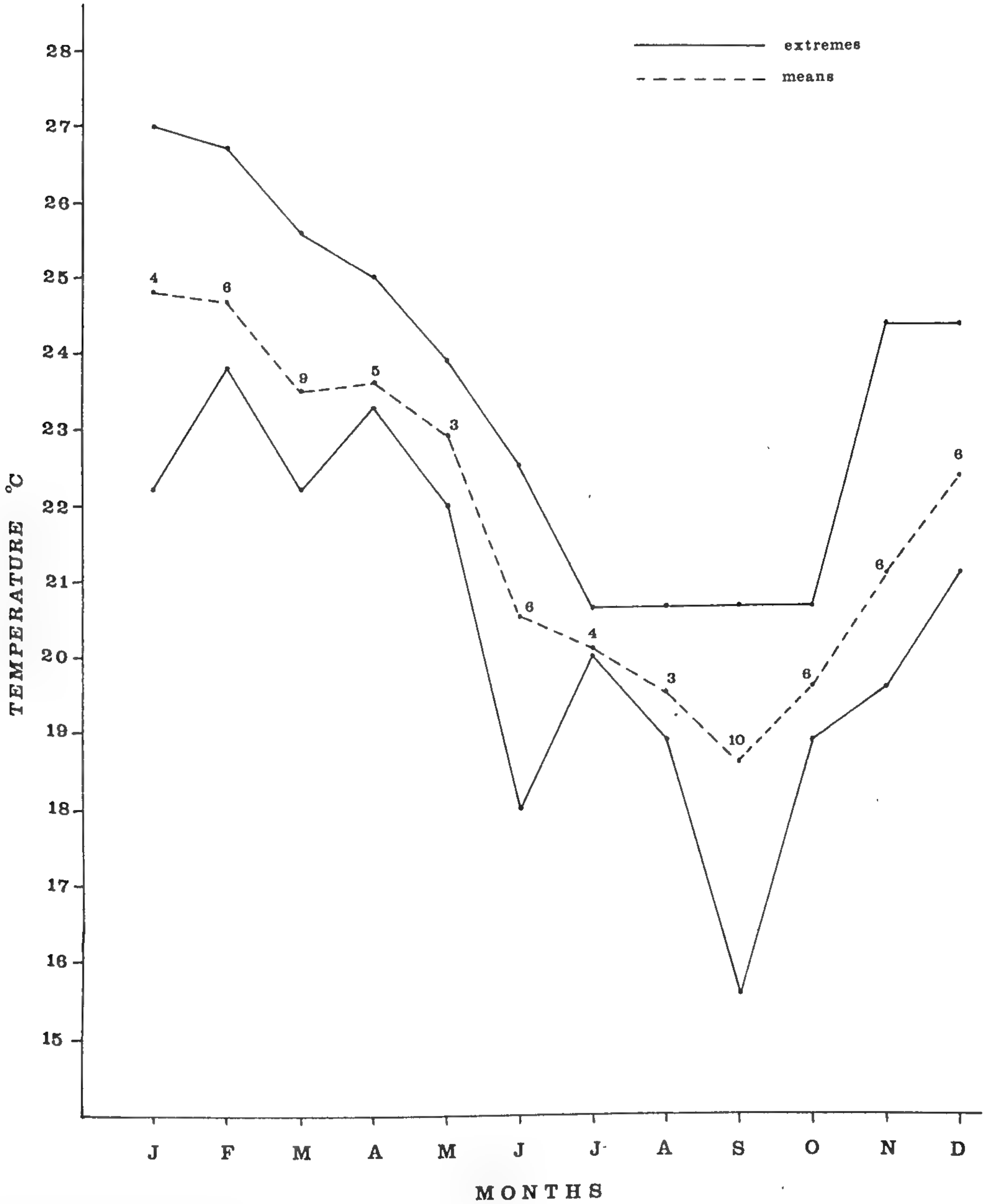

Fig. 2. Sea surface temperatures (°C) around Lord Howe Island. Numbers refer to the number of stations utilized per month.

The most striking feature of the marine habitat to one familiar with tropical coral reefs is the lush growth of algae, probably brought about by the relative scarcity of herbivorous fish schools which keep algae on tropical reefs grazed down to a stubble. The algae are mainly of tropical and subtropical genera, such as *Padina* and *Dictyota*, but in luxuriant thalli not seen in the Great Barrier Reef.

Fishes are generally scarce in the sandy areas of the lagoon. However, in rocky areas around the periphery and in the rich coralliferous areas the following species were found to be the most abundant in 1973: *Anampses elegans*, *Apogon norfolcensis*, *Goniistius ephippium*, *Paraglyphidodon polyacanthus*, *Parma polylepis*, *Pseudolabrus luculentus* and *Trachypoma macracanthus*. Of lesser abundance in the lagoon were *Amphiprion maccullochi*, *Belonepterygion fasciolatum*, *Chaetodon flavirostris*, *C. trincinctus*, *Coris* sp., *Parupeneus signatus* and *Eupomacentrus gascoynei*. These species range down to at least 16 metres.

The most common fishes seen while diving outside the lagoon in 10-15 metres in rocky areas were *Apogon norfolcensis*, *Apogon* sp., *Chromis hypsilepis*, *Eupomacentrus gascoynei*, *E. fasciolatus*, *Glyphidodontops notialis*, *Goniistius ephippium*, *Paraglyphidodon polyacanthus*, *Parma polylepis*, *Pempheris* spp., *Pseudolabrus luculentus* and *Trachypoma macracanthus*.

The greatest number of both species and individuals was observed below 20 metres depth in the vicinity of North Islet. *Paracaesio pedleyi*, *Labracoglossa nitida* and *Pseudanthias* sp. occurred here in large schools. *Chromis hypsilepis* and *Pseudolabrus luculentus* were still among the most common species at depths below 35 metres.

FAUNAL COMPOSITION AND ZOOGEOGRAPHY

The 11 most speciose families with the number of species for each indicated in brackets are as follows: Labridae (47), Pomacentridae (26), Gobiidae (23), Chaetodontidae (22), Myctophidae (18), Serranidae (17), Muraenidae (13), Blenniidae (13), Carangidae (12), and Acanthuridae (12). Thus, about 10% of the total number of families contain approximately 45% of the species. An additional 16 families are represented by 5-10 species each and 49 families by only a single species. Of the 11 most speciose groups, all except the Myctophidae are typically abundant around coral reefs. Myctophids are well represented due to specimens cast ashore after storms. No mid-water work was conducted on the 1973 expedition. Although storm conditions, with winds up to 140 km/h, prevailed for several days during our stay, no deepwater fishes were taken from the beach. No midwater or bottom trawling has ever been completed in the close vicinity of Lord Howe Island. Such operations in the future will doubtless increase the known fauna. The 31 species of deepwater fishes representing 10 families were all beach specimens, indicating the island's proximity to deep water and perhaps the influence of upwelling, as well as storms.

A zoogeographic analysis of the fish fauna is presented in Table 1. Each category in the table is mutually exclusive of the others (*i.e.*, a given species occurs only in one category). The tropical Indo-Pacific category is distinguished from the tropical Pacific by records, or by the lack thereof, of species from the Indian Ocean. The vast majority of species in both categories are not found in the eastern Pacific. Australian species are included in most of the different categories.

Most of the species found at Lord Howe Island also occur off eastern Australia. This is not surprising, considering the relatively short distance to the Australian continent and the presence of a well developed coral reef. However, the Lord Howe fauna is depauperate when compared with other coral reef localities. Approximately 850 species have been taken at the Capricorn Group at the southern extreme of the Great Barrier Reef (Talbot, unpublished). Perhaps twice this number of species occurs over the entire extent of this

Table 1. Zoogeographic Analysis of the Lord Howe Island Fish Fauna

Distribution	No. Species	% of inshore fishes	% of total fishes
Tropical Indo-Pacific	164	42.1	36.7
Oceanic-midwater and pelagic (mostly widespread)	54	—	12.1
Common to Lord Howe Island and Australia	51	13.1	11.4
Tropical Pacific	50	12.8	11.2
Common to Lord Howe Island,[1] southern Australia and New Zealand[2]	30	7.7	6.7
Uncertain	28	7.2	6.3
Worldwide tropical and subtropical inshore	16	4.1	3.6
Lord Howe Island — Norfolk endemics	15	3.8	3.4
Tropical and subtropical western South Pacific	11	2.8	2.5
Common to Lord Howe Island, eastern Australia and/or New Caledonia	10	2.6	2.2
Common to Lord Howe Island and New Zealand[2]	9	2.3	2.0
Common to Lord Howe Island, Australia and Melanesia	6	1.5	1.3
Common to Lord Howe Island, Australia and Japan	3	0.8	0.7

Inshore species	390
Pelagic and offshore species	54
Freshwater species	3
Total species	447

[1] Includes Norfolk Island and Middleton Reef

[2] Includes Kermadec Islands

massive reef complex. The lower water temperatures at Lord Howe Island are doubtless limiting for fishes, as they are likely to be for corals. Some of the uncommon species, which were observed only, or one or two specimens collected, may represent expatriates that originated from the warmer waters and are not present as breeding populations at Lord Howe Island. *Lienardella fasciata, Coris gaimard, Pomacentrus pavo,* and *Chromis nitidus* are typical examples of species which fall in this category. The vagaries of southern currents and the annual fluctuations in water temperature extremes may well result in a change in faunal composition from one period to another. The dynamic nature of the faunal composition due to the dependence of recruitment from other areas for certain species might at least partially account for the fact that we collected only about 65% of the total number of species known from the island.

Our collecting methods did not capture larger oceanic species, such as the scombroids, and according to local residents, the fishing competition held during our stay did not result in the variety of fishes caught in some previous years. The occurrence of some species, such

as the food fish *Chrysophrys auratus*, is apparently variable. According to local residents, this species is present only for a few months in some years and not in others. This cold water species, known from the southern half of Australia and New Zealand, apparently does not consistently breed at Lord Howe Island.

The largest category of fishes found at Lord Howe is composed of reef species which are widely distributed in the tropical Indian Ocean and western Pacific. Indeed, approximately 75% of the inshore fauna is comprised of tropical species. About 15% of the inshore fishes are temperate forms confined to the region which encompasses New Zealand and southern Australia. Relatively few species are endemic to Lord Howe Island (Table 2). Nearby Middleton Reef and Norfolk Island are herein considered as part of the Lord Howe Island endemic region. Waite (1910; 1916) compared the faunal composition of Lord Howe, Norfolk, and the Kermadec Islands. However, this information is of limited use as the two latter areas were inadequately sampled. Further collections there will no doubt reveal species previously known only from Lord Howe Island. A number of the temperate species in the above categories are abundant at Lord Howe Island.

Table 2. Fish Species Endemic to the Lord Howe Island Region

Amphiprion mccullochi
Bathygobius aeolosoma
Cantherhines longipinnis
Chaetodon tricinctus[1,2]
Chironemus microlepis[1]
Cirrhitus splendens
Enigmapercis sp.
Genicanthus semicinctus
Gymnothorax annasona[1,2]
Insopiscis altipinnis
Muraenichthys nicholsae[1]
Navodon analis
Norfolkia squamiceps[1]
Syngnathus howensis
Vauclusella rufopileum[1]

[1] also recorded from Norfolk Island [2] also recorded from Middleton Reef

Briggs (1974) considered Lord Howe Island a distinct zoogeographic province that included Norfolk Island and Middleton and Elizabeth Reefs. The Lord Howe-Norfolk Province was established in part on the basis of Waite's (1916) data giving 22% endemic shore fish species. We have greatly reduced that number to less than 4% for Lord Howe and expect that intensive collecting at Norfolk would produce similar results.

If such a low percentage of endemism is not indicative of a distinct zoogeographic province, it is difficult to place the region in one of Brigg's two recognised provinces of eastern Australia. While a large percentage of the shore fishes are tropical, significant numbers are found also in subtropical and temperate regions of eastern Australia (Table 1). These latter species are often the most abundant and many of the tropical species may represent expatriates. For these reasons we think Lord Howe should be considered part of a transition zone between the tropical and warm temperate regions of eastern Australia.

A small, but nevertheless interesting, segment of the fauna is composed of species which are relatively widespread across the western portion of the South Pacific. In the first report of fishes from remote Easter Island, Kendall and Radcliffe (1912) stated that the 22

species which they studied seemed closer to those of Norfolk Island (and hence also Lord Howe Island) than Mangareva (Tuamotus), which is nearer. However, John E. Randall and Gerald R. Allen, who collected fishes at Easter in 1969 and raised the fish fauna to 109 species, found that most of the fishes at the island are wide-ranging tropical Indo-Pacific species; thus there is a closer faunal tie to Mangareva and other more tropical islands of the Indo-Pacific than to Norfolk and Lord Howe (Randall, 1970). Nevertheless, there is a small but significant segment of Easter's fish fauna which links it to Norfolk and Lord Howe. The muraenid eels *Enchelycore ramosus, Gymnothorax porphyreus,* and *G. panamensis,* the serranid *Trachypoma macracanthus,* and the labrid *Anampses femininus* are common to Easter and Lord Howe islands (the two *Gymnothorax* range to the eastern Pacific), but do not occur in tropical localities. *Gymnothorax eurostus* and *Seriola lalandi* are also found in this southern zone of latitude but occur in the higher latitudes of the northern hemisphere as well, thus exhibiting an anti-tropical distribution. In addition, there are species at Easter Island of subtropical genera such as *Goniistius, Pseudolabrus, Bathystethus,* and *Navodon* which are closely related to species from Lord Howe Island and environs.

Some of the fishes common to Easter and Lord Howe were collected by Randall in 1970-71 at the islands of Pitcairn and Rapa which are intermediate in location at 25°S and 27°30'S, respectively. Also taken at these islands was an undescribed parrotfish (*Scarus*) which later was collected at the southern Great Barrier Reef and was sighted by Allen at Lord Howe Island. In addition, there is an undescribed angelfish of the genus *Genicanthus* from Pitcairn and Raivavae, Austral Islands which is closely related to the endemic *G. semicinctus* from Lord Howe Island (Randall, in press).

A few inshore fishes are known to occur in both temperate and subtropical Australia and Japan. Three of the Lord Howe species exhibit a similar distribution. These are perhaps relict forms which were once widespread over the entire western Pacific. Additional studies are needed in order to determine the faunal relationships between these widely separated areas. It is possible that some of the Australian species will prove to be distinct when they are compared closely with their Japanese counterparts.

The following 23 species are newly recorded from the waters of continental Australia in the body of the checklist: *Synodus englemani, Ceratoscopelus warmingi, Diaphus fragilis, D. perspicillatus, Hygophum hygomi, Myctophum nitidulum, Notoscopelus resplendens, Scopelopsis multipunctatus, Coryphaena equiselis, Bathystethus cultratus, Pempheris vanicolensis, Apogon coccineus, Chaetodon mertensii, Macropharyngodon meleagris, Pseudocheilinus hexataenia, Pseudojuloides cerasinus, Plagiotremus laudandus, Eviota smaragdus, Paragobiodon lacunicola, P. xanthosoma, Ptereleotris evides, Zebrasoma scopas* and *Torquigener altipinnis.* These species are represented by previously unrecorded specimens in the collections of the Australian Museum.

METHODS OF PRESENTATION

We have adopted the phylogenetic arrangement proposed by Greenwood *et al.* (1966), except in a few cases different family names are used. For example, we have retained Monacanthidae and Balistidae, whereas these two groups were included in the Balistidae by Greenwood *et al.*

The accepted Australian common name appears immediately after the scientific name of each family. The common name is followed by the initials of the co-author(s) primarily responsible for that particular section. Under the family heading the species are arranged alphabetically by genus and species. An asterisk after the specific name indicates a new record for Lord Howe Island. Abbreviated literature citations which include the author, year of publication, page number, and locality, are given for the original description, the first Lord Howe Island record for the species, and in a few cases junior synonyms. The complete

reference is listed at the end of the paper. The literature citations are followed by a brief paragraph containing information on relative abundance, habitat, depth distribution, taxonomic problems, and geographic distribution. In many cases the exact number of specimens taken in 1973 is indicated. However, the number of specimens for species listed as common or abundant does not appear. These species are generally represented by a series of at least 10-20 specimens at either the Australian Museum, Sydney or the Bernice P. Bishop Museum, Honolulu (abbreviated as AMS and BPBM in the subsequent text). Catalogue numbers are given for unidentified or undescribed species. Catalogue numbers for specimens collected during February 1973 are as follows: AMS I. 17357-I. 17424; BPBM 14736-14951.

SPECIES ACCOUNTS

CARCHARHINIDAE . . . WHALER AND TIGER SHARKS (J.R.P.)

Carcharhinus amblyrhynchos

Carcharias (Prionodon) amblyrhynchos Bleeker, 1856d: 467 (Solombo, Red Sea).

Carcharhinus menisorrah (non Müller and Henle, 1839). — Waite, 1904a: 140 (in part, Lord Howe Island).

Galeolamna macrurus (non Ramsay and Ogilby, 1887). — Whitley, 1940a: 97 (Lord Howe Island).

Two specimens in AMS collections (I. 5425 and IA. 1285) from 1903 and 1925. Widespread in tropical Indo W.-Pacific including eastern Australia.

Carcharhinus galapagensis

Carcharias galapagensis Snodgrass and Heller, 1905: 343 (Galapagos).

Carcharhinus menisorrah (non Müller and Henle, 1839). — Waite, 1904a: 140 (in part, Lord Howe Island).

Common outside the lagoon and inside at night. This species was kindly identified by Prof. J. A. F. Garrick of New Zealand. Six X-rayed specimens had the following vertebral counts: precaudal 106-108, caudal 95-102. An insular species, known from all oceans.

Galeocerdo cuvier

Squalus cuvier LeSueur, 1822: 351 (Australia).

Galeocerdo rayneri Macdonald and Barron, 1868: 369 (Lord Howe Island).

Teeth in collection (AMS I. 7846) from a 1907 specimen. Worldwide distribution including eastern Australia.

Prionace glauca

Squalus glaucus Linnaeus, 1758: 235 (Western Europe).

Prionace glauca. — Ogilby, 1899: 732 (Lord Howe Island).

Two embryos in collection (AMS IB. 674-5) from 1900. World-wide distribution including eastern Australia.

SQUALIDAE . . . DOGFISH SHARKS (D.F.H.)

Isistius brasiliensis

Scymnus brasiliensis Quoy and Gaimard, 1824: 198 (Brazil).

Isistius brasiliensis. — Waite, 1900: 195 (Lord Howe Island).

Nine specimens at AMS taken between 1900 and 1971. Tropical and subtropical circumglobal distribution including eastern Australia.

DASYATIDAE . . . STINGRAYS (D.F.H.)
*Taeniura brocki**

Taeniura brocki Schultz, 1953: 18 (Marshall Islands).

Several individuals observed (2 collected) in the lagoon. Widespread in the tropical western Pacific.

ALBULIDAE . . . BONE FISHES (J.R.P.)
Albula vulpes

Esox vulpes Linnaeus, 1758: 313 (Bahamas).

Albula neoguinaica. — Whitley, 1940: 398 (Lord Howe Island).

None collected in 1973. The specimen upon which Whitley's record is based cannot be found at AMS, but a second specimen (AMS I. 1405) was collected in 1945. Circumglobal, tropical and subtropical distribution including eastern Australia.

ANGUILLIDAE . . . FRESHWATER EELS (J.R.P.)
Anguilla australis

Anguilla australis Richardson, 1841: 22 (Tasmania).

Anguilla australis. — Ramsay, 1888: 32 (Lord Howe Island).

One juvenile collected in brackish water. Numerous specimens in AMS collections. Eastern Australia, Lord Howe and Norfolk Islands, and New Zealand.

Anguilla reinhardti

Anguilla reinhardti Steindachner, 1867a: 15 (Queensland).

Anguilla reinhardti. — Waite, 1901: 36 (Lord Howe Island).

Common in freshwater. Known from eastern and southern Australia, New Caledonia and Lord Howe Island.

MURAENIDAE . . . MORAY EELS (D.F.H.)
Anarchias sp.*

Two specimens collected outside the lagoon in 2-25 m. One deposited at AMS (I. 17367-008) and one at BPBM.

Echidna nebulosa

Muraena nebulosa Ahl, 1789: 7 (East Indies).

Muraena nebulosa. — Ramsay, 1888: 32 (Lord Howe Island).

Two specimens collected at Lord Howe Island in 1918 at AMS. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Enchelycore ramosa**

Gymnothorax ramosus Griffin, 1926: 539 (New Zealand).

One specimen collected outside the lagoon in 25 m. Known from Lord Howe Island, Easter Island (Randall and McCosker, in press) and New Zealand.

Gymnothorax annasona

Gymnothorax flavimarginatus. — Waite, 1904a: 145 (Lord Howe Island).

Gymnothorax flavimarginata annasona Whitley, 1937: 220 (Middleton Reef, Lord Howe Island, and Norfolk Island).

Several specimens collected from lagoon and outer reef habitats to depths of 15 m. Known from Middleton Reef, Lord Howe Island, and Norfolk Island.

*Gymnothorax chilospilus**

Gymnothorax chilospilus Bleeker, 1864: 103, 142 (Indonesia).

One specimen collected at Middle Beach. Widespread in the tropical western Pacific including eastern Australia.

Gymnothorax eurostus

Thyrsoidea eurosta Abbott, 1861: 478 (Hawaiian Islands).

Gymnothorax chalazias Waite, 1904a: 145 (Lord Howe Island).

Common in lagoon and outer reef habitats. Previously 3 specimens were known from Lord Howe Island, including the type of *G. chalazius* (AMS I. 5479). Anti-tropical, north and south Pacific.

*Gymnothorax meleagris**

Muraena meleagris Shaw and Nodder, 1795: pl. 220 (Pacific).

One individual observed at Middle Beach in 1 m. Two unreported specimens at AMS had been previously collected in 1907 and 1910. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Gymnothorax nubilus

Muraena nubila Richardon, 1848: 81 (Norfolk Island).

Gymnothorax nubilus. — Waite, 1904a: 145 (Lord Howe Island).

One specimen speared off the Admiralty Islands in 25 m. Previously known from 6 specimens. James Stuart's unpublished painting (No. 144) in the library of the Linnean Society of N.S.W., identified as *Lycodontis* sp. from Norfolk Island by Whitley (1955: 130), appears to be this species. Reported from Norfolk Island, Lord Howe Island and New Zealand.

*Gymnothorax panamensis**

Muraena panamensis Steindachner, 1876: 19 (Panama).

One specimen collected off North Rock in 30 m. Known also from Easter Island, Isla San Felix and certain localities in the eastern Pacific including the Galapagos Islands (Randall and McCosker, in press).

Gymnothorax porphyreus

Murenophis porphyreus Guichenot 1848a: 343 (Chile).

Muraena afra. — Ramsay, 1888: 32 (Lord Howe Island).

Gymnothorax thyrsoidea. — Waite, 1904a: 144 (Lord Howe Island).

Common in lagoon (5 collected) and outer reef habitats. Ogilby recorded this species as *Muraena afra* (AMS I. 1561 and I. 1563). Subsequently specimens have been called *G. thyrsoidea* based on identification by Boulenger (Waite, 1904a). Chile, Peru, Juan Fernandez Island, Isla San Felix, and Easter Island (Randall and McCosker, in press).

Gymnothorax sp. A*

One specimen (AMS I. 17456-001) 340 mm TL of this striking eel was presented by a local resident. It has an irregular network of brown lines over a background of light brown and white. The gill opening is surrounded by a white ring.

Gymnothorax sp. B*

One specimen (BPBM 14927) 315 mm TL, which is marked with white reticulations and a black ring around the gill opening, was collected.

Gymnothorax sp. C*

One specimen (BPBM 14786) 216 mm TL collected which has small black spots and white margins on the anal and dorsal fins.

CONGRIDAE . . . CONGER EELS (D.F.H.)
Ariosoma howensis

Congermuraena mellisii. — Ogilby, 1889a: 72 (Lord Howe Island).

Congrellus gilberti Ogilby, 1898b: 288 (in part, Lord Howe Island specimens only).

Congermuraena howensis McCulloch and Waite, 1916: 438-439 (Lord Howe Island).

Known from the three syntypes (AMS I. 13691), and two additional specimens (AMS I. 4148 and I. 7045). Nothing is known of its habits. Castle (1964) provisionally regarded this species as a synonym of *A. mauritianus* (Pappenhein, 1914) which had been described from larval stages. Known only from Lord Howe Island, but probably widespread.

Conger cinereus

Conger cinereus Rüppell, 1828: 115 (Red Sea).

Leptocephalus cinereus. — Waite, 1900: 197 (Lord Howe Island).

Known from Lord Howe Island from one specimen (AMS I. 4278), which is abnormal in having only one pore behind the eye, but agrees in other features with *C. cinereus.* Widespread in the tropical Indo-W. Pacific.

*Conger wilsoni**

Gymnothorax wilsoni Bloch and Schneider, 1801: 529 (Australia).

Two specimens collected in shallow rocky areas of the lagoon. It is common in New South Wales and northern New Zealand. The species has been recorded in Australia as *C. labiatus.* Kanazawa (1958), however, has applied the name *C. wilsoni,* which was inadequately described, to this species and recognized the related *C. verreauxi,* common in southern Australia and generally regarded as *C. wilsoni* in Australia. Castle (1964) followed the nomenclature of Kanazawa for these 2 species in New Zealand. Also known from southern Queensland, New South Wales, Western Australia, and northern New Zealand.

Gnathophis sp.

Congermuraena longicauda. — Waite, 1900: 196 (Lord Howe Island).

Gnathophis habenata longicauda. — Castle, 1963: 19 (in part; Lord Howe Island and Karuah River Mouth, N.S.W. only).

Common (3 specimens collected) outside the lagoon down to 25 m. Specimens are at AMS from southern Queensland and Sydney. The specimens have been compared with the type of *Gnathophis longicauda* and there are significant differences. Castle (1963) listed vertebral counts for 2 specimens of this species, which had been misidentified as *Gnathophis longicauda* (=*G. habenata*).

OPHICHTHYIDAE . . . SNAKE EELS (D.F.H.)

Callechelys marmoratus

Dalophis marmorata Bleeker, 1853c: 247 (Ceram).

Callechelys marmoratus. — McCulloch, 1923b: 14 (Lord Howe Island).

Known from one specimen (AMS IA. 939) collected in 1922. Widespread in the tropical western Pacific.

Callechelys melanotaenia

Callechelys melanotaenia Bleeker, 1864: 66 (Ambon).

Callechelys melanotaenia. — Waite, 1903: 21 (Lord Howe Island).

Known from Lord Howe Island on the basis of two previously collected specimens (AMS I. 5193 and IA. 3252). Widespread in the tropical Indo-W. Pacific.

Cyclophichthys cyclorhinus

Ophichthus versicolor. — Waite, 1903: 22 (Lord Howe Island).

Ophichthus cyclorhinus Fraser-Brunner, 1934: 466-468 (Great Barrier Reef).

One specimen dipnetted under a night light. Previously 3 specimens were known from the island (AMS IA. 949, I. 2508, I. 13671). McCosker (personal communication) believes that this species may be a synonym of *Elapsopis versicolor* (Richardson).

Malvoliophis pinguis

Ophichthus pinguis Günther, in Brenchley, 1873: 430 (Solomon Islands).

Bascanichthys pinguis. — Waite, 1903: 22 (Lord Howe Island).

The only known specimen (AMS I. 5239) was destroyed in 1911. Also recorded from the Solomon Islands, Great Barrier Reef, and New South Wales.

*Muraenichthys laticaudatus**

Myropterura laticaudata Ogilby, 1897: 247-248 (Fiji).

Two specimens collected over sand in the lagoon. Specimens at AMS from New Guinea and Western Australia.

Muraenichthys nicholsae

Muraenichthys nicholsae Waite, 1904: 142 (Lord Howe Island).

Common in lagoon and outer reef over sand in 2-25 m. Although McCosker (1970) did not treat this species, it appears distinct, possibly close to *M. macropterus* Bleeker. Known only from Lord Howe Island.

*Myrichthys maculosus**

Muraena maculosa Cuvier, 1817a: 232 (no locality given).

This species is recorded from 1 specimen collected in 1923 (AMS IA. 1397). Another specimen at AMS was taken at Norfolk Island. Widespread in the tropical Indo-W. Pacific.

Ophichthys sp.*

The single specimen (AMS I. 13692), taken in 1915, is damaged and lacks most teeth.

CLUPEIDAE . . . SARDINES AND SPRATS (J.R.P.)
Spratelloides gracilis

Spratelloides gracilis Temminck and Schlegel, 1846: 238 (Japan).

Spratelloides gracilis. — Ogilby, 1889a: 72 (Lord Howe Island).

A school of 600 individuals was collected outside the lagoon in 10 m during an explosive station. Widespread in the tropical Indo-W. Pacific including eastern Australia, where it has been recorded as *S. japonicus.*

ENGRAULIDAE . . . ANCHOVIES (J.R.P.)
*Engraulis australis**

Atherina australis White, 1790: 296 (New South Wales).

One postlarva dipnetted over deep water. Known only from eastern Australia, New Zealand and Lord Howe Island.

GALAXIIDAE . . . JOLLYTAILS (D.F.H.)
Galaxias maculatus

Mesites maculatus Jenyns, 1842: 119 (Tierra del Fuego, South America).

Austrocobitis attenuatus. — Whitley, 1935: 41 (Lord Howe Island).

Known from 3 juveniles collected from freshwater streams in 1889 and 1962. Recorded from South Australia, Victoria, Tasmania, New South Wales, southern Queensland, Lord Howe Island, New Zealand, Chile, Argentina, and Falkland Islands.

GONOSTOMATIDAE . . . LIGHT FISHES (J.R.P.)
Maurolicus muelleri

Salmo muelleri Gmelin, 1789: 1378 (Norway).

Maurolicus pennanti australis. — McCulloch, 1923b: 114 (Lord Howe Island).

The only Lord Howe Island specimen is that recorded by McCulloch (AMS I. 960). Inadequate study precludes the recognition of more than 1 species in the genus (Grey, 1964). Apparently cosmopolitan distribution including eastern Australia, midwater.

STERNOPTYCHIDAE . . . HATCHET FISHES (J.R.P.)
Argyropelecus aculeatus

Argyropelecus aculeatus Valenciennes (in Cuvier and Valenciennes), 1849: 302 (Azores).

Argyropelecus (Sternoptychides) amabilis Ogilby, 1888c: 313 (Lord Howe Island).

The lectotype and 2 paralectotypes (AMS I. 16263-001, -002) of Ogilby's nominal species were transferred to the AMS collections in 1971 with all of the other fish types in the Macleay Museum at the University of Sydney. Worldwide distribution including eastern Australia, midwater.

SYNODONTIDAE . . . LIZARD FISHES (B.C.R.)

*Synodus englemani**

Synodus englemani Schultz, 1953: 41 (Marshall Islands).

Rare, 1 individual collected at North Islet in 25 m. We provisionally identify the specimen as *S. englemani*. The Australian members of *Synodus* are currently being studied by Russell. Specimens have recently been collected from One Tree and Lizard Islands, Great Barrier Reef, new record for Australia. Previously known only from the Marshall Islands, this species is probably widespread throughout the Indo-W. Pacific including eastern Australia.

*Synodus hoshinonis**

Synodus hoshinonsis Tanaka, 1917: 38 (Hiro, Japan).

Rare, 1 individual collected in 25 m outside the lagoon off Mt. Lidgbird. Known previously from southern Japan and eastern Australia where it has been recorded as *Synodus similis* McCulloch (1921), an apparent junior synonym (Matsubara, 1938).

*Synodus houlti**

Synodus houlti McCulloch, 1921: 165 (Capricorn Group, Queensland).

Synodus japonicus (non Houttuyn, 1782). — McCulloch, 1921: 165 (in part, Lord Howe Island).

Four of the 9 specimens in AMS (I. 5341-2, I. 1954) from Lord Howe Island apparently referred to by McCulloch (1921) as *Synodus japonicus* are *S. houlti*. Although Norman (1935) placed *S. houlti* in the synonymy of *S. variegatus*, examination of further material leaves little doubt that *S. houlti* is a distinct species (Russell, in prep.). Known also from eastern Australia.

Synodus variegatus

Salmo variegatus Lacepede, 1803: 157 (no locality given).

Synodus japonicus. — McCulloch, 1921: 165 (in part, Lord Howe Island).

Collected in lagoon and outer reef habitats in 1-5 m over sand. Widespread in the tropical Indo-W. Pacific including eastern Australia, where it was recorded as *Synodus japonicus* (Houttuyn) by McCulloch (1921).

Synodus sp.*

Rare, 2 specimens, both 153 mm SL, collected at Ball's Pyramid in 31 m and off Phillip Point in about 20 m. Also known from the southern Great Barrier Reef and northern New Zealand, the proposed type locality (Russell, in prep.). Specimens deposited at AMS (I. 17421-001) and BPBM (14655).

*Trachinocephalus myops**

Salmo myops Schneider (ex Forster ms), in Bloch, 1801: 421 (St. Helena).

Several unreported specimens from Lord Howe Island are deposited at AMS. Circumtropical distribution including eastern Australia.

MYCTOPHIDAE . . . LANTERN FISHES (J.R.P.)

*Centrobranchus choerocephalus**

Centrobranchus choerocephalus Fowler, 1904: 754 (Hawaii).

Three juveniles dipnetted over deep water. Tropical Pacific, subtropical south Pacific, and tropical Indian (?) oceans (Bekker, 1964), midwater.

Ceratoscopelus warmingi

Scopelus (Nyctophus) warmingii Lütken, 1892: 259 (North Atlantic).

Lampanyctus townsendi (non Eigenmann and Eigenmann, 1889). — McCulloch, 1923b: 115 (Lord Howe Island).

Known from the Atlantic, Indian and south Pacific oceans including eastern Australia (new record for Australia based on numerous examples recently taken by midwater trawl off Sydney) and New Zealand, midwater.

*Diaphus fragilis**

Diaphus fragilis Tåning, 1928: 61 (North Atlantic).

Aethoprora perspicillata (non Ogilby, 1898a). — Waite, 1904a: 149 (in part, Lord Howe Island).

One specimen (AMS I. 3191) in collection. Worldwide including eastern Australia (new record for Australia based on specimens recently taken by midwater trawl off Sydney), midwater.

*Diaphus danae**

Diaphus danae Tåning, 1932: 140 (New Zealand).

One unrecorded specimen (AMS IA. 3257) collected on beach in 1927. Known from the South Pacific including New Zealand, midwater.

*Diaphus garmani**

Diaphus garmani Gilbert, 1906: 258 (Cuba).

One unrecorded specimen (AMS IA. 958) collected from beach in 1922. Probably worldwide tropical and subtropical distribution, midwater.

Diaphus perspicillatus

Aethoprora perspicillata Ogilby, 1898a: 36 (Lord Howe Island).

Probably worldwide distribution (recorded as *D. elucens*), midwater, including eastern Australia (new record for Australia, based on specimens recently taken by midwater trawl off Sydney; Whitley's (1939) record from New South Wales is based on a specimen of *D. mollis*; Whitley's (1933) figure of *D. perspicillatus* from Lord Howe Island is the new species discussed below) and possibly New Zealand. The holotype is at the Queensland Museum (QM I. 794), registered in 1912.

Diaphus sp.*

Aethoprora perspicillata (non Ogilby, 1898a). — Waite, 1904a: 149 (in part, Lord Howe Island).

This species is the most common *Diaphus* from the beach in the AMS collections. It was figured as *D. perspicillatus* by Whitley (1933: fig. 1) and will be described in a paper on the lanternfishes of eastern Australia (Paxton, ms), midwater.

Gonichthys barnesi

Gonichthys barnesi Whitley, 1943: 174 (Lord Howe Island).

One dipnetted over deep water. Widespread from the Indian Ocean to New Zealand including eastern Australia, midwater.

Hygophum hygomi

Scopelus hygomi Lütken, 1892: 256 (North Atlantic).

Myctophum hygomi. — Waite, 1904a: 153 (Lord Howe Island).

Antitropical worldwide distribution including eastern Australia (Paxton, ms) and New Zealand, midwater.

Hygophum reinhardti

Scopelus reinhardti Lütken, 1892: 257 (North Atlantic).

Myctophum reinhardti. — Waite, 1904a: 154 (Lord Howe Island).

Four juveniles dipnetted over deep water. Known from the North Atlantic and Pacific including eastern Australia, midwater.

Myctophum asperum

Myctophum asperum Richardson, 1845: 41 (no locality given).

Dasyscopelus naufragus Waite, 1904a: 154 (Lord Howe Island).

Worldwide distribution including eastern Australia, midwater.

Myctophum nitidulum

Myctophum nitidulum Garman, 1899: 266 (North Pacific).

Myctophum opalinum (non Goode and Bean, 1896). — Waite, 1904a: 153 (Lord Howe Island).

Seven juveniles dipnetted over deep water. Worldwide distribution including eastern Australia (new record for Australia, based on specimens recently taken by midwater trawl off Sydney), midwater.

*Myctophum obtusirostre**

Myctophum pristilepis obtusirostre Tåning, 1928: 54 (North Atlantic).

One unrecorded specimen (AMS IA. 3632) collected from beach in 1928. Nafpaktitis (1973) has recently sorted out the confusion between this species, *M. brachygnathum* and *M. pristilepis.* Tropical Atlantic and Indo-W. Pacific, midwater.

Myctophum phengodes

Scopelus phengodes Lütken, 1892: 253 (South Atlantic).

Myctophum phengodes. — Waite, 1904a: 152 (Lord Howe Island).

One juvenile dipnetted over deep water. Circumglobal distribution in the southern hemisphere including eastern Australia and New Zealand, midwater.

*Myctophum spinosum**

Scopelus spinosus Steindachner, 1867b: 711 (China).

One unrecorded specimen (AMS IB. 4179) collected from beach in 1922. Known from the South Pacific and Indian Oceans, midwater.

Notoscopelus resplendens

Lampanyctus resplendens Richardson, 1845: 42 (no locality given).

Notoscopelus ejectus Waite, 1904a: 150 (Lord Howe Island).

Worldwide distribution including eastern Australia (new record for Australia, based on numerous specimens recently taken by midwater trawl off Sydney) and New Zealand, midwater.

Scopelopsis multipunctatus

Scopelopsis multipunctatus Brauer, 1906: 146 (South Atlantic).

Scopelopsis caudalis Whitley, 1932a: 333 (Lord Howe Island).

Circumglobal distribution in the southern hemisphere including eastern Australia (new record for Australia based on specimens recently taken by midwater trawl off Sydney) and New Zealand, midwater.

Symbolophorus barnardi?

Myctophum humboldti barnardi Tåning, 1932: 128 (South Africa).

Scopelus hookeri Whitley, 1953: 134 (Lord Howe Island).

The taxonomy of the southern hemisphere species in this genus needs clarification. Circumglobal? in the southern oceans including eastern Australia and New Zealand, midwater.

ALEPISAURIDAE . . . LANCET FISHES (J.R.P.)
Alepisaurus ferox

Alepisaurus ferox Lowe, 1833: 104 (Madeira).

Alepisaurus richardsonii. — Whitley, 1940: 411 (Lord Howe Island).

The only specimen from Lord Howe Island is that recorded by Whitley. Further studies are needed to determine if *A. richardsoni* (Bleeker, 1855b) is a distinct species (Gibbs and Wilomovsky, 1966). Widespread in the Pacific including eastern Australia, surface and midwater.

PLOTOSIDAE . . . MARINE CATFISHES (G.R.A.)
Plotosus lineatus

Silurus lineatus Thunberg, 1791: 190 (Indian Ocean).

Plotosus arab. — Ogilby, 1889a: 71 (Lord Howe Island).

Large schools of juveniles observed occasionally both in lagoon and outer reef habitats in 2-10 m. Several adults captured in gill nets near shore in the lagoon. Smith (1941) has shown that *P. lineatus* is a senior synonym of *P. anguillaris* (Bloch, 1794). Widespread in the tropical Indo-W. Pacific including eastern Australia.

GONORHYNCHIDAE . . . BEAKED SALMON (D.F.H.)

Gonorhynchus greyi

Rhynchana greyi Richardson, 1845: 44 (Western Australia).

Gonorhynchus greyi. — Ramsay, 1888: 32 (Lord Howe Island).

Ogilby (1889) reported this species as common off sandy beaches. Also known from temperate Australia and New Zealand.

GOBIESOCIDAE . . . CLINGFISHES (D.F.H.)

Aspasmogaster tasmaniensis

Crepidogaster tasmaniensis Günther, 1861: 507 (Tasmania).

Diplocrepis costatus. — Waite, 1904: 179 (Lord Howe Island).

Twenty-one specimens collected in lagoon and outer reef habitats in 1-5 m. Also known from New South Wales, Victoria, Tasmania, South Australia, and Western Australia.

Lepadichthys caritus

Lepadichthys caritus Briggs, 1969: 464 (Seychelles).

Lepadichthys caritus. — Coleman, 1974: 86 (Lord Howe Island).

Eight specimens collected from a surge channel outside the lagoon in 4 m. Previously known from the Indian Ocean, but recently recorded by Allen and Starck (1973) from the Palau Islands, New Guinea, and the Great Barrier Reef.

Lepadichthys frenatus

Lepadichthys frenatus Waite, 1904a: 180 (Lord Howe Island).

Three specimens collected from coral in the lagoon in 1-2 m. Widespread in the western tropical Pacific.

Gobiesocid sp.*

Two specimens collected from surge channels outside the lagoon off Phillip Point in 4 m.

ANTENNARIIDAE . . . ANGLER FISHES (G.R.A.)

Antennarius coccineus

Chironectes coccineus Lesson, 1830: 143 (Mauritius).

Antennarius coccineus. — Ogilby, 1889a: 20, 61 (Lord Howe Island).

A number of Lord Howe Island specimens in AMS collection. Widespread in the tropical Indo-W. Pacific.

Antennarius commersonii

Chironectes commersonii Cuvier, 1817b: 431 (Mauritius).

Antennarius commersonii. — Ramsay, 1888: 32 (Lord Howe Island).

Two specimens from Lord Howe Island in AMS collection. Widespread in the tropical Indo-W. Pacific.

*Phrynelox tridens?**

Chironectes tridens Temminck and Schlegel, 1845: 159 (Japan).

We tentatively identify a 180 mm specimen from Lord Howe Island at AMS as *tridens*. Positive identification is not possible because of a missing illicium. Previously known from Indonesia and Japan.

*Phrynelox zebrinus**

Phrynelox zebrinus Schultz, 1957: 75 (Port Jackson, Australia).

None collected in 1973, but one specimen subsequently sent to AMS by an island resident. It is entirely blackish. Schultz (1967) described *P. atra* as distinct from *P. zebrinus* on the basis of the dark coloration. However the transformation of the *zebrinus* phase to the *atra* phase in this species is well known to fish collectors and aquarists in the Sydney area. Further study is necessary to determine the true status of this species which is essentially identical to *P. striatus* (Shaw), but has 2 rather than 3 tentacles on the first dorsal spine or illicium.

Phrynelox sp.*

One specimen (AMS I. 17413-001) 104 mm SL presented to the expedition by a local resident. It appears to be closely related to *P. striatus* (Shaw), but the colour pattern does not agree with the variable markings of the many specimens of *striatus* at AMS from New South Wales. Both species have 10 pectoral rays.

MORIDAE . . . BEARDED CODS (J.R.P.)

Lotella callarias

Lotella callarias Günther, 1863: 116 (Victoria, Australia).

Lotella callarias. — Ogilby, 1899: 745 (Lord Howe Island).

Approximately 30 individuals collected outside the lagoon in 1-30 m. Future studies may show this species to be conspecific with *L. rhacina* (Bloch and Schneider, 1801) from New Zealand. Known only from Lord Howe Island and the southern half of Australia.

OPHIDIIDAE . . . CUSK EELS (D.F.H.)

Brotula multibarbata

Brotula multibarbata Temminck and Schlegel, 1846: 251-253 (Japan).

Brotula multibarbata. — Whitley, 1964b: 191 (Lord Howe Island).

Recorded from 1 individual (AMS IB. 5833) previously collected at Lord Howe Island. Widespread in the tropical Indo-W. Pacific.

Dinematichthys longifilis

Diancistrus longifilis Ogilby, 1899: 744 (Lord Howe Island).

Dinematichthys longifilis. — Waite, 1904b: 225 (Lord Howe Island).

Three specimens collected from coral in the lagoon and 7 from 20-25 m outside the lagoon. As this genus is in need of revision we tentatively use the above name for this species. It is possibly identical with *D. mizolepis* (Günther) or *D. iluocoeteoides* Bleeker. Both orange and brown individuals were taken. Known from the Great Barrier Reef and Lord Howe Island.

EXOCOETIDAE . . . FLYING FISHES (J.R.P.)

*Cheilopogon heterurus?**

Exocoetus heterurus Rafinesque, 1810: 58 (Sicily).

One juvenile collected in 1916, (AMS I. 13895) is tentatively identified as this species. A second small specimen (IB. 6321) of this genus, regurgitated by a seabird in 1962, is unidentifiable to species. The many adult flying fishes observed outside the lagoon were neither collected nor identified to species. Sub-tropical Atlantic and Pacific oceans (Parin, 1961).

*Exocoetus obtusirostris**

Exocoetus obtusirostris Günther, 1866: 283 (Cape Verde Islands).

One juvenile (AMS I. 13894) taken in 1916. Warm waters of Atlantic and South Pacific oceans (Parin, 1961).

Hirundichthys cribrosus

Exocoetus cribrosa Kner, 1867: 326 (Sydney).

Exocoetus dovii (non Gill, 1863). — Ogilby, 1889a: 71 (Lord Howe Island).

Exonautes rondeletii (non Cuvier and Valenciennes, 1846). — Waite, 1904a: 156 (Lord Howe Island).

Exonautes fulvipes Ogilby, 1908b: 8 (Lord Howe Island).

Three specimens, including the holotype of Ogilby's nominal species (I. 1955) in the AMS collections. Known from New Zealand and Australia (Parin, 1961).

*Hirundichthys speculiger**

Exocoetus speculiger Valenciennes (in Cuvier and Valenciennes), 1846: 94 (Mauritius).

Seven juveniles dipnetted over deepwater. Cosmopolitan in tropical waters (Parin, 1961) including eastern Australia and New Zealand.

HEMIRAMPHIDAE . . . GARFISHES (J.R.P.)

Euleptorhamphus viridis

Hemiramphus viridis van Hasselt, 1823: 31 (India).

Euleptorhamphus longirostris. — Waite, 1903: 24 (Lord Howe Island).

Four specimens taken outside the lagoon, where it was commonly observed flying. Circumglobal distribution in tropical and subtropical oceanic waters including eastern Australia.

Hyporhamphus australis

Hemiramphus australis Steindachner, 1866: 471 (New South Wales).

Hemirhamphus intermedius (non Cantor, 1842). — Ogilby, 1889a: 71 (Lord Howe Island).

Common in the lagoon. Restricted to eastern Australia, Lord Howe and Norfolk islands (Collette, 1974).

BELONIDAE . . . LONG TOMS (J.R.P.)

*Platybelone argalus**

Belone argalus LeSueur, 1821: 125 (West Indies, near Guadaloupe).

Three specimens collected, 2 close to shore, 1 over deep water. Four unrecorded specimens (AMS IA. 1435, IA. 1579-81) collected in 1923. According to the data presented in Parin (1967: Fig. 5), Cressey and Collette (1970: Fig. 176), and Collette (pers. comm.), these specimens are the southernmost record of the species. Circumglobal including tropical Australia.

SCOMBERESOCIDAE . . . KING GARS AND SAURIES (J.R.P.)

Scomberesox saurus

Esox saurus Walbaum, 1792: 92 (England).

Scombresox forsteri. — Ramsay, 1888: 32 (Lord Howe Island).

Represented by 3 specimens at AMS. Parin (1968: 284) considers the southern population at most only subspecifically distinct from that of the North Atlantic. Circumglobal distribution in the southern hemisphere (including eastern Australia and New Zealand as *S. forsteri*), North Atlantic and Mediterranean.

ATHERINIDAE . . . HARDYHEADS (J.R.P.)

Atherion maccullochi

Atherion maccullochi Jordan and Hubbs, 1919: 30 (Lord Howe Island).

Thirty specimens collected at Middle Beach. Known only from Lord Howe Island and Queensland.

Hypoatherina lacunosa

Atherina lacunosa Bloch and Schneider, 1801: 112 (New Caledonia).

Atherina lacunosa. — Waite, 1898: 60 (Lord Howe Island).

Numerous specimens collected, mostly from the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

ISONIDAE . . . FLOWERS OF THE WAVES (J.R.P.)

*Iso rhothophilus**

Tropidostethus rhothophilus Ogilby, 1895: 323 (New South Wales).

Fifteen specimens collected in the surge zone against cliffs outside the lagoon. Known only from New South Wales, Western Australia and Lord Howe Island.

TRACHICHTHYIDAE . . . ROUGHIES (J.R.P.)

Hoplostethus elongatus

Trachichthys elongatus Günther, 1859: 10 (New Zealand).

Hoplostethus elongatus. — McCulloch, 1923a: 14 (Lord Howe Island).

One specimen collected outside the lagoon in 25 m. Known only from southern Australia, Lord Howe Island and New Zealand.

HOLOCENTRIDAE . . . SOLDIER FISHES (G.R.A.)

*Flammeo sammara**

Sciaena sammara Forsskål, 1775: 1248 (Red Sea).

One individual observed in the lagoon in 6 m by W. Doak. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Myripristis borbonicus**

Myripristis borbonicus Cuvier (in Cuvier and Valenciennes), 1829: 489 (Mauritius).

One specimen taken with explosives at North Islet in 30 m. Measures 159 mm SL, which is large for the species. Widespread in the tropical Indo-W. Pacific.

*Myripristis kuntee**

Myripristis kuntee Valenciennes (in Cuvier and Valenciennes), 1831, 7: 487 (Mauritius).

One adult specimen obtained at North Rock. Otherwise known only from Hawaii, Japan, Indonesia and Mauritius. Most authors have used the name *chryseres* for this species (P. Guézé, personal communication). Widespread in the tropical Indo-W. Pacific.

*Myripristis murdjan**

Sciaena murdjan Forsskål, 1775: 48 (Red Sea).

One individual seen by J.E.R. outside the lagoon in 15 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Ostichthys pilwaxii**

Myripristis pillwaxii Steindachner, 1893: 215 (Honolulu).

One specimen collected with explosives at North Islet in 45 m. Known from Lord Howe Island, Hawaiian Islands. Also collected at Easter Island by J.E.R. and G.R.A. and at Réunion by P. Guézé.

*Plectrypops lima**

Myripristes lima Valenciennes (in Cuvier and Valenciennes), 1831: 371 (Mauritius).

One specimen collected with rotenone at North Islet in 25 m. Widespread in the tropical Indo-W. Pacific.

ZEIDAE . . . DORIES (J.R.P.)

Zenopsis nebulosus

Zeus nebulosus Temminck and Schlegel, 1845: 123 (Japan).

Zenopsis scopus Waite, 1903: 30 (Lord Howe Island).

The holotype (AMS I. 5397) of Waite's nominal species is 38 mm SL. A second juvenile (AMS IA. 1394), 49 mm SL, was collected at Lord Howe Island in 1922. Waite's species has not been recorded in the literature since the original description and his 1904 checklist. In all

counts the two specimens agree with *Z. nebulosus* from eastern Australia, although no small juveniles are available for comparison. Waite (1903) recorded a ventral count of I,7. Both juveniles have I,5, with two rays on one fin split to the base in the type. Widespread in the Pacific, from eastern Australia to Japan and California.

VELIFERIDAE . . . VEILFINS (J.R.P.)
*Metavelifer multiradiatus**

Velifer multiradiatus Regan, 1907: 633 (north-west Australia).

One specimen, 235 mm SL, speared outside the lagoon in 45 m. Previously recorded from Mozambique, Australia, Hawaii and Japan.

AULOSTOMIDAE . . . PAINTED FLUTEMOUTHS (J.R.P.)
Aulostomus chinensis

Fistularia chinensis Linneaus, 1766: 515 (India).

Aulostomus chinensis. — Waite, 1900: 198 (Lord Howe Island).

Aulostomus chinensis waitei Whitley, 1940: 413 (Lord Howe Island).

Rare; 3 specimens taken plus 3 additional (including holotype of nominal subspecies) at AMS. Widespread in the tropical Indo-Pacific including eastern Australia.

FISTULARIIDAE . . . FLUTEMOUTHS (J.R.P.)
Fistularia commersoni

Fistularia commersonii Rüppell, 1835: 142 (Red Sea).

Fistularia depressa. — Waite, 1898: 61 (Lord Howe Island).

Small individuals common in the lagoon. Widespread in the tropical Indo-Pacific including eastern Australia. The correct name and distribution for this species, *F. petimba* of most authors, was provided by R. Fritzsche (pers. comm.).

MACRORAMPHOSIDAE . . . BELLOWS FISHES (J.R.P.)
Macroramphosus gracilis

Centriscus gracilis Lowe, 1839: 86 (Madeira).

Macrorhamphosus gracilis. — Waite, 1900: 199 (Lord Howe Island).

Macroramphosus molleri Whitley, 1930: 117 (New South Wales).

Two Lord Howe Island specimens in AMS collections (I. 4340, IA. 4768). Mohr (1937: 37) placed Whitley's *M. molleri* in the synonymy of *M. scolopax*. The holotype (AMS B. 7163) is the same specimen figured by Waite (1899: Pl. 7, fig. 2), which Mohr listed as a synonym of *M. gracilis*. The holotype and 2 Lord Howe Island specimens (both less than 30 mm SL) all have a short second dorsal spine which is closer to the head than the caudal base. Circumglobal distribution in tropical and subtropical waters including eastern Australia.

SYNGNATHIDAE . . . PIPEFISHES AND SEA HORSES (J.R.P.)
Hippocampus planifrons?

Hippocampus planifrons Peters, 1877: 851 (north-west Australia).

Hippocampus abdominalis (non Lesson, 1827). — Ogilby, 1889a: 72 (Lord Howe Island).

Only 1 Lord Howe Island specimen at AMS (AMS I. 1959) collected in 1888, a large male 230 mm long and presumably the basis of Ogilby's record. However, the size is larger than recorded for this species and the meristics (D. 19, BR 11, TR 41) also match *H. trimaculatus* given by Weber and de Beaufort (1922) from the south-west Pacific. Recorded only from eastern and western Australia.

Hippocampus sp. A

Hippocampus punctulatus. — Ogilby, 1889b: 732 (Lord Howe Island).

The only specimen from Lord Howe Island was registered in the Queensland Museum (QM I. 1008) in 1913 as *H. kuda,* and could not be located in 1973.

Hippocampus sp. B

Hippocampus histrix. — Whitley and Allan, 1958: Fig. 6 (3) (Lord Howe Island).

The small size of the only specimen (AMS IA. 2424) collected in 1926 precludes accurate identification. The short snout and 38 tail rings are not characteristic of *H. histrix.*

Micrognathus boothae

Micrognathus boothae Whitley, 1964b: 162 (Lord Howe Island).

Known from the holotype (AMS IB. 5992) collected in 1962, and a second specimen recently recorded from Fiji (Dawson and Randall, 1975).

Solegnathus dunckeri

?*Solenognathus* sp., Ramsay, 1888: 32 (Lord Howe Island).

?*Solenognathus spinosissimus.* — Ogilby, 1889a: 72 (Lord Howe Island).

Solegnathus dunckeri Whitley, 1927a: 294 (Lord Howe Island).

Represented at AMS by the holotype (AMS I. 14336) and 2 other specimens mentioned in the original description (IA. 2428-9). The basis of the earlier records is unknown. Recorded only from eastern Australia and Lord Howe Island.

Syngnathus howensis

Parasyngnathus howensis Whitley, 1948: 77 (Lord Howe Island).

Previously known only from the male holotype. Eight females (66-90 mm SL) collected in the lagoon in .5-2 m and 2 females (77-91 mm SL) collected in 1966 by H. Cogger. Meristic ranges are dorsal 27-29, body rings 16-17, tail rings 34-36, subdorsal rings ½-1¼+5½-7; colouration distinctive, each ring plate with a few dark spots and narrow lines. The species appears closely related to *S. caldwelli* (Herald and Randall, 1972) from Easter Island, from which it differs slightly in counts and colouration. Known only from Lord Howe Island.

SCORPAENIDAE . . . SCORPION FISHES (G.R.A.)

*Ablabys slacksmithi**

Amblyapistis slacksmithi Whitley, 1958: 45 (Heron Island, Great Barrier Reef).

One specimen (40 mm SL) in the AMS collection (I. 17043-001) taken in shallow water by H. Cogger in 1966. Previously known only from the holotype.

*Dendrochirus brachypterus**

Pterois brachyptera Cuvier (in Cuvier and Valenciennes), 1829: 270 (no locality given).

Three unreported specimens at AMS (I. 7865, IB. 5713, IB. 6338) from Lord Howe Island. Widespread in the Indo-W. Pacific including eastern Australia.

Dendrochirus zebra

Pterois zebra Cuvier (in Cuvier and Valenciennes), 1829: 270 (Mauritius).

Pterois zebra. — Ramsay, 1888: 32 (Lord Howe Island).

Specimens reported by Waite examined at AMS. Widespread in the tropical Indo-Pacific including eastern Australia.

Insopiscis altipinnis

Cocotropus altipinnis Waite, 1903: 41 (Lord Howe Island).

Known only from the holotype, a specimen 34 mm SL in the AMS collection.

Pterois volitans

Gasterosteus volitans Linnaeus, 1758: 296 (Ambon).

Pterois volitans. — Ogilby, 1889a: 60 (Lord Howe Island).

Observed occasionally (one collected and deposited in BPBM) in lagoon and outer reef area in 2-35 m. Widespread in the tropical Indo-Pacific including eastern Australia; a protected species at Lord Howe Island, where it is more common than at other localities known to the authors.

Scorpaena cookii

Scorpaena cookii Günther, 1874: 8 (Kermadec Islands).

Scorpaena cookii. — Ogilby, 1889b: 155 (Lord Howe Island).

Common in lagoon and outer reef habitats in 2-35 m. Reported also from the Kermadec Islands, Norfolk Island, and New South Wales.

*Scorpaenodes littoralis**

Sebastella littoralis Tanaka, 1917a: 10 (Misaki, Japan).

Several specimens collected with rotenone in lagoon and outer reef habitats in 3-20 m. Probably widespread in the western Pacific.

*Scorpaenodes parvipinnis**

Scorpaena parvipinnis Garrett, 1863: 105 (Hawaiian Islands).

One specimen collected with rotenone at North Rock in 25 m. Widespread in the tropical Indo-W. Pacific.

Scorpaenodes scaber

Sebastes scaber Ramsay and Ogilby, 1885: 577 (Port Jackson, New South Wales).

Scorpaena scabra. — Ogilby, 1889a: 60 (Lord Howe Island).

Several specimens collected with rotenone in lagoon and outer reef habitats in 2-25 m. Known also from New South Wales.

Scorpaenopsis sp.*

One specimen collected with quinaldine outside lagoon in 15 m.

TRIGLIDAE . . . GURNARDS (J.R.P.)
*Chelidonichthys kumu**

Trigla kumu Lesson, 1830: 214 (New Zealand).

One unrecorded specimen (AMS IA. 3256) collected in 1927 by R. Baxter. Widespread in Indo-W. Pacific from South Africa to Japan including Australia and New Zealand.

PLATYCEPHALIDAE . . . FLATHEADS (J.R.P.)
*Platycephalus caeruleopunctatus**

Platycephalus caeruleopunctatus McCulloch, 1922: 120 (New South Wales).

One unrecorded specimen (AMS I. 10655) collected in 1926 by R. Pedley. Known from eastern Australia.

DACTYLOPTERIDAE . . . FLYING GURNARDS (J.R.P.)
*Dactyloptena orientalis**

Dactylopterus orientalis Cuvier (in Cuvier and Valenciennes), 1829: 134 (Indian Ocean).

Three juveniles dipnetted over deep water. Widespread in the tropical Indo-W. Pacific including eastern Australia. Recently recorded also from northern New Zealand (Moreland, 1975).

PEGASIDAE . . . SEA MOTHS (G.P.W.)
Pegasus draconis

Pegasus draconis Linnaeus, 1766: 418 (India).

Pegasus draco. — Ogilby, 1890: 1028 (Lord Howe Island).

One specimen collected from beach in February, 1974. The specimen recorded by Ogilby is not now in AMS. His record, in a short paper on lizards and fishes, has been overlooked by later authors. Known from India to Japan, and eastern Australia.

SERRANIDAE . . . GROUPERS AND ROCK CODS (D.F.H.)
Acanthistius cinctus

Plectropoma cinctum Günther, 1859: 162 (Norfolk Island).

Plectropoma cinctum. — Ogilby, 1889a: 53 (Lord Howe Island).

Observed occasionally (seven collected) in lagoon and outer reef habitats in 2-30 m. Known from Lord Howe Island, Norfolk Island, Kermadec Islands, northern New Zealand, and New South Wales.

*Acanthistius serratus**

Plectropoma serratum Cuvier (in Cuvier and Valenciennes), 1828: 399 (Western Australia).

One specimen at AMS (AMS I. 10697) collected before 1910. The colour pattern is identical with that of specimens from New South Wales. The species was originally

described from a spotted individual from Western Australia. In the limited material available to us from Western Australia the juveniles have a few spots, but the adults are banded. The name *A. serratus* is provisionally used here for the east Australian spotted form. Should this form prove distinct the next available name is *Acanthistius ocellatus* Günther with New South Wales as the type locality. Also known from southern Queensland to eastern Victoria and Western Australia.

*Cephalopholis argus**

Cephalopholis argus Bloch and Schneider, 1801: 311 (E. Indies).

Rare, 1 specimen speared outside the lagoon off Phillip Point in 15 m. Widespread and abundant for a serranid in the tropical Indo-W. Pacific, including eastern Australia.

Cephalopholis sexmaculatus

Serranus sexmaculatus Rüppell, 1828: 107 (Red Sea).

Serranus ouatalibi. — Günther, 1859: 120 (in part, Lord Howe Island).

Serranus punctatus. — Boulenger, 1893: 183 (in part, Lord Howe Island).

Cephalopholis coatesi Whitley, 1937a: 124 (Townsville, Queensland).

The specimens upon which this record is based are the first recorded from Lord Howe Island (Günther, 1859). They have been recorded under two names of Western Atlantic species which are now regarded as *Cephalopholis fulva.* Two of the specimens were borrowed from the British Museum and do not belong to *C. fulva.* The specimens have 14 and 15 dorsal rays and 17 or 18 pectoral rays. They are both dried skins and have faded considerably. Each has a dark mark at the top of the caudal peduncle suggestive of a saddle. There are 2 faint spots at the anterior tip of the lower jaw and the body and head are covered with small blue spots. One specimen has faint dark markings along the back suggestive of the dark spots of *C. sexmaculatus.* The specimens are 195 and 237 mm SL. The species was described from the Great Barrier Reef as *C. coatesi* by Whitley. Widespread in tropical Indo-W. Pacific.

*Ellerkeldia huntii**

Plectropoma huntii Hector, 1875: 240 (Chatham Island).

Several specimens collected in 20-30 m outside the lagoon. The species is closely related to *E. maccullochi* from New South Wales, but differs in having narrower bands on the body and in having a vertical bar at the end of the caudal peduncle, which is lacking in *E. maccullochi.* Known from Lord Howe Island and New Zealand.

Epinephelus daemelii

Serranus daemelii Günther, 1876: 391 (New South Wales).

Serranus daemelii. — Ogilby, 1889a: 53 (Lord Howe Island).

Serranus fuscoguttatus. — Ogilby, 1889a: 53 (Lord Howe Island).

Epinephelus forsythi Whitley, 1937: 222 (Lord Howe Island).

Common in lagoon and outer reef habitats in 2-45 m. Ogilby (1889) recorded specimens of over 35 kg from Lord Howe Island and 50 kg individuals from northern New South Wales. The angling record is 64 kg. Several earlier specimens including the type of *E. forsythi* are at AMS. Whitley (1937) described specimens of *E. microdon* from Middleton and Elizabeth

reefs as *E. forsythi* and he figured one individual of *E. daemelii* from Lord Howe Island. He selected the specimen recorded by Ogilby (1889) as *E. fuscoguttatus* (AMS I. 1793) as the holotype of *E. forsythi.* This species has been recorded from New Guinea, but no specimens have been located from farther north than southern Queensland. The New Guinea record probably represents a misidentification. Known from southern Queensland, New South Wales, Lord Howe and Norfolk islands, and northern New Zealand.

Epinephelus fasciatus

Perca fasciata Forsskål, 1775: 40 (Red Sea).

Epinephelus fasciatus. — Waite, 1901: 200 (Lord Howe Island).

Four individuals observed (1 collected) outside the lagoon in 8-25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Epinephelus hoedti**

Serranus hoedti Bleeker, 1855a: 406 (Ambon).

One specimen (AMS I. 7854) from Lord Howe Island collected before 1907. Widespread in the Indo-W. Pacific including eastern Australia.

*Epinephelus howlandi**

Serranus howlandi Günther, 1873: 8 (Howland Island).

One specimen 255 mm at AMS (I. 6019), collected before 1903, is identified here after the description and figure of *Serranus howlandi* of Günther (1873). Some workers have regarded the species as a synonym of *E. corallicola,* while others have treated it as a synonym of *E. maculatus.* The specimen agrees with Günther's figure, except that there are faint spots on the pectoral fin. The gill rakers are shorter than the gill filaments except at the angle, the spots are large and there are 16 dorsal rays. In southern Queensland and northern New South Wales this species can easily be confused with the coral rock cod (*E. corallicola* of Australian authors). *E. howlandi* differs from *E. corallicola* in having a smaller posterior nostril and lacking scales on the maxilla. Widespread in the tropical South Pacific.

*Epinephelus medurensis**

Serranus medurensis Günther, 1873: 8 (Marshall Islands).

One specimen speared in the lagoon at Comet's Hole. Widespread in the tropical Pacific.

*Epinephelus melanostigma**

Epinephelus melanostigma Schultz, 1953: 348-351 (Swains Island, Samoan Group).

One specimen taken by spear. It is similar to *E. howlandi*; however, the large spot on the back extending onto the dorsal fin is more prominent and the hexagonal spots form a network on the body. In addition, the specimen of *E. howlandi* has smaller round spots which are more widely spaced. Widespread in the tropical western Pacific.

Epinephelus merra

Epinephelus merra Bloch, 1793: 17 (Japanese Sea).

Epinephelus merra. — Ogilby, 1899: 730 (Lord Howe Island).

Not common at Lord Howe, only a few individuals observed in the lagoon in 2-5 m, 1 collected. Widespread and generally abundant in the tropical Indo-W. Pacific including eastern Australia.

*Epinephelus microdon**

Serranus microdon Bleeker, 1856a: 86 (Java).

Epinephelus forsythi Whitley, 1937: 322 (in part, Middleton and Elizabeth Reefs specimens only).

Randall (1964) indicated that this species has been confused with *E. fuscoguttatus*. One specimen (AMS I. 5225) was collected from Lord Howe Island in 1902. The species is similar to *E. daemelii*, but differs in having spots on the ventral surface of the body and on the anal and caudal fins and in having the maxilla scaled. Widespread in the tropical Indo-W. Pacific.

Epinephelus rhyncholepis

Serranus rhyncholepis Bleeker, 1852b: 749 (Indonesia).

Epinephelus rhyncholepis. — Waite, 1904a: 165 (Lord Howe Island).

Several specimens were taken during a local fishing competition. Previously the species was known from Lord Howe Island from 2 specimens (AMS I. 5669 and I. 6025). Widespread in the tropical western Pacific.

*Franzia squamipinnis**

Serranus (Anthias) squamipinnis Peters, 1855: 236 (Mozambique).

Observed occasionally (6 collected) outside the lagoon in 10-30 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Pseudanthias sp.

Anthias cichlops (non Bleeker). — Ogilby, 1888b: 741 (Lord Howe Island).

Pseudanthias hypselosoma (non Bleeker). — Waite, 1904: 204 (Lord Howe Island).

Large aggregations frequently observed outside the lagoon around rocky islets in 10-45 m. This species is probably undescribed. Ogilby (1888b) identified the species as *cichlops* Bleeker (described from Sumatra) on the basis of a single specimen washed up on the beach. Our material differs from the description of *cichlops* given by Weber and de Beaufort (1931), who examined the type. It is deeper bodied (3.0 in SL compared with "somewhat more than 3") and has a higher lateral line scale count (46 [1], 47 [2], 48 [3], and 50 [6] compared with 45 for *cichlops*). Waite (1904a) reidentified Ogilby's specimen as *Pseudanthias hypselosoma*, another Bleeker species originally described from New Guinea. This species differs from our material by having fewer pectoral rays (17 compared with 19), fewer lateral line scales (44-46 compared with counts given above), and is deeper bodied (2.5 in SL compared with 3.0). The Lord Howe Island species exhibits striking sexual dichromatism. Males are mostly fuschia coloured with a yellowish head, red pelvics and median fins, and a large yellowish patch covering most of the basal half of the caudal fin. Females are fuschia on the anterior half of the body and yellow on the posterior half with yellow fins. This species has also been taken at One Tree Island, Capricorn Group, Great Barrier Reef and was observed by G. Allen in 30 m off the southern tip of New Caledonia. Two lots containing 93 specimens, 71-105 mm SL, deposited at AMS and BPBM. The largest lot, AMS I. 17366-021, includes 72 specimens, 80-105 mm SL.

Trachypoma macracanthus

Trachypoma macracanthus Günther, 1859: 167 (Norfolk Island).

Trachypoma macracanthus. — Ramsay, 1888: 32 (Lord Howe Island).

Extremely abundant in lagoon and outer reef habitats to depths of 45 m. Known from New South Wales, Lord Howe Island, Norfolk Island, Kermadec Islands, northern New Zealand and Easter Island.

PSEUDOPLESIOPIDAE . . . FALSE PRETTYFINS (D.F.H.)

Pseudoplesiops sp.*

Eight specimens were collected from coral in the lagoon and from 20-25 m outside the lagoon. This species is similar to *P. sargenti* Schultz in lacking a lateral line and an opercular spot and in having palatine teeth. It differs from *P. sargenti* in having 26 dorsal rays and a fleshy keel in the intermandibular space. Six lots containing 22 specimens deposited at AMS and BPBM. The largest lot, BPBM 14925, includes 8 specimens 28-32 mm SL.

GRAMMISTIDAE . . . SOAP FISHES (G.R.A.)

*Grammistes sexlineatus**

Perca sexlineata Thunberg, 1792: 142 (E. Indies).

One individual observed outside the lagoon by J.E.R. in 16 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

PSEUDOGRAMMIDAE . . . DOTTYBACKS (G.R.A.)

*Pseudogramma polyacantha**

Pseudochromis polyacanthus Bleeker, 1856b: 375 (Ternate).

One specimen collected with rotenone at North Islet in 25 m. Widespread and abundant in the Indo-W. Pacific.

PLESIOPIDAE . . . PRETTYFINS (D.F.H.)

Plesiops sp.

Plesiops nigricans (non Rüppell). — Ramsay, 1888: 32 (Lord Howe Island).

Common in coral outside the lagoon in 2-25 m. It also has been taken at One Tree Island and Heron Island on the Great Barrier Reef, Norfolk Island and New Caledonia. The species is similar to *P. caeruleolineatus*, but differs in having 12 dorsal spines. It will be described by J. Randall and P. Fourmanoir. Six lots containing 37 specimens deposited at AMS and BPBM. The largest lot, AMS I. 17363-004, includes 23 specimens, 52-100 mm SL.

ACANTHOCLINIDAE . . . BANDED LONG-FIN (B.C.R.)

Belonepterygion fasciolatum

Acanthoclinus fasciolatus Ogilby, 1889a: 63 (Lord Howe Island).

Common in lagoon and outer reef habitats in 1-25 m. Known also from tropical eastern Australia.

THERAPONIDAE . . . GRUNTERS (J.R.P.)

Therapon jarbua

Sciaena jarbua Forsskål, 1775: 50 (Red Sea).

Terapon jarbua. — Waite, 1900: 200 (Lord Howe Island).

The basis of Waite's record, apparently the only specimen collected from Lord Howe Island, was sent on exchange to an unnamed U.S. institution in 1896. Widespread in the tropical Indo-W. Pacific including eastern Australia.

KUHLIIDAE . . . FLAG-TAIL PERCH (G.R.A.)
Kuhlia mugil

Sciaena mugil Forster (in Bloch and Schneider), 1801: 541 (Tahiti).

Kuhlia taeniura. — Waite, 1894: 217 (Lord Howe Island).

Several juveniles collected at Ned's Beach in 0-2 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

PRIACANTHIDAE . . . RED BULLSEYES (G.R.A.)
*Priacanthus cruentatus**

Labrus cruentatus Lacepede, 1800: 452 (Martinique).

Several specimens collected with a gill net in the lagoon in 2 m. Circumglobal distribution including eastern Australia.

APOGONIDAE . . . CARDINAL FISHES (G.R.A.)
Apogon chrysurus

Apogon chrysurus Ogilby, 1889a: 54 (Lord Howe Island).

Several specimens collected in both lagoon and outer reef habitats in 2-25 m. Known from Lord Howe Island, New South Wales, and Queensland.

*Apogon coccineus**

Apogon coccineus Rüppell, 1835: 88 (Red Sea).

Several specimens collected in rocky areas outside the lagoon in 1-4 m. Eighteen unrecorded specimens from the Capricorn Group, Queensland in the AMS collection, new record for Australia. Widespread in the tropical Indo-W. Pacific. *Apogon erythrinus* Snyder, type locality Hawaii, is a synonym (T. H. Fraser, personal communication).

Apogon norfolcensis

Apogon norfolcensis Ogilby, 1888a: 990 (Norfolk Island and Lord Howe Island).

Abundant in both lagoon and outer reef habitats in 2-25 m. Previously known only from Lord Howe and Norfolk islands. Recently discovered in a collection from New Caledonia by T. H. Fraser (personal communication).

Apogon sp. A*

Large aggregations encountered in the lagoon and occasionally outside in rocky areas. This species, which may be undescribed (T. H. Fraser, personal communication), reaches a standard length of approximately 90-100 mm and is characterized by a pale ground colour with 3 narrow stripes on the upper sides and a dark spot at the base of the middle caudal rays. Five lots containing 36 specimens, 19-105 mm SL, deposited at AMS and BPBM. The largest lot, AMS I. 17362-032, includes 30 specimens, 20-75 mm SL.

Apogon sp. B*

Pristiapogon diversus. — Whitley (non Smith and Radcliffe), 1964: 166 (Kenn Reef, Coral Sea).

Very abundant in rocky areas outside the lagoon in 2-25 m. Infrequently encountered in the lagoon. This is another species, which according to T. H. Fraser, may be undescribed. He stated (personal communication) that it is closely related to *A. diversus* (Smith and Radcliffe). It attains a maximum standard length of approximately 100 mm and is largely pale with a dark spot at the base of the middle caudal rays and narrow dark upper and lower caudal margins. Thirteen lots containing 100 specimens, 17-110 mm SL, deposited at AMS and BPBM. The largest lot, AMS I. 17364-016, includes 69 specimens, 25-45 mm SL.

*Cheilodipterus macrodon**

Cheilodipterus macrodon Lacepède, 1802: 252 (Réunion Island).

Several individuals observed (one collected) outside the lagoon in caves in 8-15 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Cheilodipterus quinquelineatus**

Cheilodipterus quinquelineatus Cuvier (in Cuvier and Valenciennes), 1828: 167 (Bora Bora).

Observed occasionally (several collected) in coralliferous areas of the lagoon in 2-8 m. Classified in *Paramia* by some authors. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Fowleria aurita?**

Apogon auritus Cuvier (in Cuvier and Valenciennes), 1831: 443 (Mauritius).

Four specimens collected in the lagoon in 1-2 m. We provisionally identify these as *F. aurita*, but Fraser (1972) emphasized a need for revision of *Fowleria* as indicated by the conflicting classifications of Lachner (1953) and Smith (1961). Widespread in the tropical Indo-W. Pacific including eastern Australia.

Howella brodiei

Howella brodiei Ogilby, 1899: 735 (Lord Howe Island).

The only Lord Howe Island specimen is the holotype (QM. 777). The family allocation of this species is currently under study. Widespread in the tropical Indo-W. Pacific (G. Mayer, personal communication), midwater.

SILLAGINIDAE . . . WHITINGS (J.R.P.)

Sillago ciliata

Sillago ciliata Cuvier (in Cuvier and Valenciennes), 1829: 415 (Tasmania).

Sillago ciliata. — Waite, 1901: 47 (Lord Howe Island).

Two large specimens collected in the lagoon over sand. Also known from Australia and Melanesia.

BRANCHIOSTEGIDAE ... TILE FISHES (J.R.P.)

Malacanthus brevirostris

Malacanthus brevirostris Guichenot, 1848b: 14 (Madagascar and Bourbon).

Malacanthus hoedti. — Ogilby, 1899: 741 (Lord Howe Island).

One specimen observed by W. Doak outside the lagoon in 45 m. Two Lord Howe Island specimens at AMS (I. 5373, I. 14347). Dooley (1974) found that *M. brevirostris* was a senior synonym of *M. hoedti.* Widespread in the tropical Indo-W. Pacific including eastern Australia.

LABRACOGLOSSIDAE . . . KNIFE FISHES (J.R.P.)
Bathystethus cultratus

Sciaena cultrata Bloch and Schneider, 1801: 343 (Norfolk Island).

Platystethus guentheri Ogilby, 1889b: 157 (Lord Howe Island).

Three specimens taken in the surge zone outside lagoon. Known from New South Wales (new record for Australia, based on a 230 mm specimen, AMS IB. 8014, speared off Port Stephens, N.S.W. in 1967), Lord Howe and Norfolk islands. Recently recorded also from northern New Zealand (Moreland, 1975).

Labracoglossa nitida

Labracoglossa nitida McCulloch and Waite, 1916: 439 (Lord Howe Island).

Several specimens collected at North Rock in 25 m. Known only from New South Wales, Lord Howe and Norfolk islands. Recently recorded also from northern New Zealand (Moreland, 1975).

ECHENEIDAE . . . SUCKER FISHES (J.R.P.)
*Echeneis naucrates**

Echeneis naucrates Linnaeus, 1758: 261 (Indian seas).

One specimen at AMS (I. 13690) taken by R. Pedley in 1915; the host was not recorded. Worldwide distribution including eastern Australia.

*Remora brachyptera**

Echeneis brachyptera Lowe, 1839: 89 (Madeira).

Two specimens taken from a 120 kg black marlin (*Makaira indica*) caught between Lord Howe Island and Ball's Pyramid. Worldwide distribution including eastern Australia.

Remora remora

Echeneis remora Linnaeus, 1758: 260 (Indian seas).

Echeneis remora. — Whitley, 1949: 23 (Lord Howe Island).

One registered specimen (AMS IA. 1429) taken by R. Baxter in 1923; no host recorded. The specimen is currently on loan to Dr. E. A. Lachner of the USNM, who has confirmed the identification. Worldwide distribution including eastern Australia.

CARANGIDAE . . . JACKS AND TREVALLYS (B.C.R.)
*Alectis ciliaris**

Zeus ciliaris Bloch, 1787a: 36 (East Indies).

Two unreported specimens (AMS I. 2452-3) collected previously at Lord Howe Island. Worldwide tropical distribution including eastern Australia.

Caranx (Pseudocaranx) nobilis

Caranx nobilis Macleay, 1881: 532 (Port Jackson).

Caranx georgianus (non Cuvier, 1833). — Ogilby, 1889a: 61 (Lord Howe Island).

Common in lagoon and outer reef habitats in 2-45 m. W. F. Smith-Vaniz (pers. comm.) reports that the Lord Howe Island specimens appear to be identical with specimens from Sydney Harbour, the type locality of *Caranx nobilis* Macleay, 1881. This species has been confused with *C. georgianus* Cuvier, 1833.

*Caranx (Carangoides) orthogrammus**

Caranx orthogrammus Jordan and Gilbert, 1882: 226 (Revillagigedos Islands).

Two unreported specimens (AMS I. 12859 and I. 4120) were collected previously at Lord Howe Island and labelled as "*Caranx ferdau*" in the collection. W. F. Smith-Vaniz, who provided the identification of this species, pointed out that the true *ferdau* lacks the series of 3-5 small yellow spots on the sides of the body which characterize *orthogrammus* and has fewer rakers on the first gill arch. It tends also to inhabit continental waters whereas *orthogrammus* has an insular distribution. *C. orthogrammus* is widespread in the tropical Indo-Pacific.

Decapterus leptosomus

Decapterus leptosomus Ogilby, 1898c: 760 (Port Jackson, New South Wales).

Decapterus sanctaehelena (non Cuvier, 1833). — Waite, 1900: 194 and 200 (Lord Howe Island).

Schools occasionally observed outside the lagoon in 10-15 m. Previously recorded as *D. sanctaehelenae*, a species which is restricted to the Atlantic. *Decapterus koheru* (Hector, 1875), described from New Zealand, may prove to be a senior synonym of *D. leptosomus*. Widespread in the south-western Pacific including eastern Australia.

Elagatis bipinnulatus

Seriola bipinnulata Quoy and Gaimard, 1824: 363 (Îles des Papoves, Indonesia).

Elagatis bipinnulatus. — Whitley, 1962: 115 (Lord Howe Island).

Recorded from Lord Howe Island by Whitley (1962) on the basis of a single specimen taken off Ball's Pyramid in 1938. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Naucrates ductor**

Gasterosteus ductor Linnaeus, 1758: 295 (pelagic).

Rare, one beach-stranded juvenile from the eastern side of the island. Worldwide distribution including eastern Australia.

*Seriola dumerili**

Caranx dumerili Risso, 1810: 175 (Mediterranean).

Several specimens previously taken from Lord Howe Island at AMS. Worldwide distribution including eastern Australia, where it has been recorded as *S. simplex* Ramsay and Ogilby (1886).

Seriola lalandi

Seriola lalandi Valenciennes (in Cuvier and Valenciennes), 1833: 208 (Brazil).

Seriola lalandi. — Ramsay, 1888: 32 (Lord Howe Island).

Common outside the lagoon, especially around offshore rocky islets in 1-45 m. The most important food fish of the Lord Howe Islanders, who call it kingfish. Worldwide in the southern hemisphere including eastern Australia.

*Seriola rivoliana**

Seriola rivoliana Valenciennes (in Cuvier and Valenciennes), 1883: 207 (type locality uncertain).

Observed occasionally at North Islet in 25-45 m. Only one individual taken (head only in collection). Worldwide distribution including eastern Australia.

Trachinotus baillonii

Caesiomorus baillonii Lacepède, 1802: 92-93 (Madagascar).

Trachinotus baillonii. — Waite, 1903: 25 (Lord Howe Island).

Widespread in the tropical western Pacific including eastern Australia.

Trachinotus botla

Scomber botla Shaw, 1803: 591 (Vizagapatam).

Trachinotus russelli (non Cuvier). — Ogilby, 1890: 1028 (Lord Howe Island).

Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Trachurus mccullochi**

Trachurus mccullochi Nichols, 1921: 479 (South Australia).

Rare, 1 specimen collected outside the lagoon in 15 m. Known also from eastern and western Australia.

CORYPHAENIDAE . . . DOLPHIN FISHES (J.R.P.)

*Coryphaena equiselis**

Coryphaena equiselis Linnaeus, 1758: 261 (high seas).

Five juveniles dipnetted over deep water. Two juveniles (AMS I. 15671-001) collected near Sydney by Collettes in 1970; new record for Australia. Apparently circumglobal in tropical and subtropical oceanic waters.

Coryphaena hippurus

Coryphaena hippurus Linnaeus, 1758: 261 (open seas).

Corphaena hippurus dampieri Whitley, 1939: 271 (Lord Howe Island).

The holotype of the nominal subspecies (AMS IA. 7561) is the only specimen from Lord Howe Island. Circumglobal in tropical and subtropical oceanic waters including eastern Australia.

BRAMIDAE . . . PELAGIC BREAM (J.R.P.)

Brama brama

Sparus brama Bonnaterre, 1788: 104 (England).

Brama rayi. — Ogilby, 1890: 1028 (Lord Howe Island).

One 420 mm specimen found on Lagoon Beach after a cyclone in September 1972. Mead (1972) considered *B. raii* a probable synonym of *B. brama.* North Atlantic and southern oceans including eastern Australia.

ARRIPIDAE . . . AUSTRALIAN SALMON (B.C.R.)

Arripis trutta

Sciaena trutta Bloch and Schneider, 1801: 542 (Queen Charlotte Sound, New Zealand).

Arripis salar. — Ramsay, 1888: 32 (Lord Howe Island).

Several specimens previously taken from Lord Howe Island are deposited at AMS. Fairbridge (1951) has produced evidence of separate breeding populations in eastern and western Australia and Whitley (1951a) regarded these as subspecies, according the subspecific name *marginata* to the east Australian form. On the basis of differences in gill raker counts, Fairbridge (1951) suggested that specimens from Lord Howe Island might belong to a different breeding population. However, gill raker counts of Lord Howe Island specimens at AMS are within the range given by Malcolm (1959) for the east Australian subspecies and we provisionally regard the two populations as the same. New Zealand specimens also seem to be identical with the east Australian form (Fairbridge, 1951). Known also from eastern and western Australia, Elizabeth and Middleton reefs, Norfolk Island, Kermadec Islands, and New Zealand.

LUTJANIDAE . . . HUSSARS (B.C.R.)

*Lutjanus amabilis**

Genyorage amabilis De Vis, 1885: 145 (Moreton Bay, Queensland).

Apparently rare, recorded here on the basis of a colour transparency of 3 specimens caught by line fishing off North Rock by Mr. S. Bradshaw, January 1974. Known also from eastern Australia.

*Lutjanus bohar**

Sciaena bohar Forsskål, 1775: 46 (Red Sea).

Rare, only 2 sightings (B. Goldman and J. Randall) outside the lagoon to 30 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Lutjanus kasmira

Sciaena kasmira Forsskål, 1775: 46 (Red Sea).

Genyorage bengalensis. — Waite, 1904a: 166 (Lord Howe Island).

Rare, 1 specimen collected in the lagoon in 3 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Paracaesio pedleyi

Paracaesio pedleyi McCulloch and Waite, 1916: 440 (Lord Howe Island).

Common outside the lagoon in deeper water (15-35 m). McCulloch and Waite distinguished this species from *Paracaesio xanthurus* Bleeker (1875) on the basis of colour and differences in the shape of the spinous dorsal fin. Further studies are necessary, however, since the differences are slight. Known also from eastern Australia.

NEMIPTERIDAE . . . CORAL BREAM (G.R.A.)
*Scolopsis bilineatus**

Anthias bilineatus Bloch, 1793: 3 (Japan).

One specimen speared in the lagoon in 4 m. No others seen. Widespread in the tropical Indo-W. Pacific including eastern Australia.

POMADASYIDAE . . . SWEETLIPS (G.R.A.)
*Plectorhynchus punctatissimus**

Diagramma punctatissimum Playfair, 1867: 851 (Seychelles).

Two subadults ("pica" colour form) collected outside the lagoon in 10-35 m and 1 adult in 20 m. Widespread in the tropical Indo-W. Pacific.

*Spilotichthys pictus**

Diagramma pictum Thunberg, 1792: 141 (no locality given).

Several individuals observed (1 collected) in the lagoon in about 5 m. Indian Ocean and tropical western Pacific including eastern Australia.

LETHRINIDAE . . . EMPERORS (B.C.R.)
Gymnocranius sp.*

Three specimens observed at Ball's Pyramid in 30-35 m. One specimen, 232 mm SL, deposited at BPBM (14908).

Lethrinus nebulosus

Sciaena nebulosa Forsskål, 1775: 52 (Red Sea).

Lethrinus opercularis. — Ogilby, 1889a: 58 (Lord Howe Island).

Rare, 1 beach stranded specimen collected at Blenkinthorpe Beach. Another specimen (AMS I. 1809) in the Australian Museum. Indian Ocean and tropical western Pacific, including eastern Australia.

*Lethrinus chrysostomus**

Lethrinus chrysostomus Richardson, 1848: 118 (Norfolk Island).

Rare, 1 specimen collected in the lagoon during a fishing competition. Known also from New Guinea, northern and eastern Australia, and Norfolk Island.

SPARIDAE . . . SNAPPERS (B.C.R.)
Chrysophrys auratus

Sciaena aurata Forster (in Bloch and Schneider), 1801: 266 (New Zealand).

Pagrus unicolor. — Ogilby, 1889a: 58 (Lord Howe Island).

The specimens upon which Ogilby's record is based have not been located. However, we have seen photographs of the species taken at Lord Howe Island and local fishermen indicate that it is caught in some years. On the basis of osteology, Yasuda and Mizuguchi (1969) have shown that the eastern Australian species, *C. guttulatus*, and the New Zealand species, *C. auratus*, are distinct. Should Lord Howe Island specimens prove to be the same as the Australian form, the name *guttulatus* will apply. However, as we have not been able to examine specimens from Lord Howe Island, we retain the name *auratus*.

MULLIDAE . . . GOAT FISHES (D.F.H.)

*Mulloidichthys flavolineatus**

Mullus flavolineatus Lacepède, 1802: 384, 406 (Mauritius).

Rare, 1 specimen of this distinctive species, often recorded as *M. samoensis*, collected in the lagoon. Also observed outside in 25-35 m. Widespread in the tropical Indo-W. Pacific.

*Mulloidichthys vanicolensis**

Upeneus vanicolensis Valenciennes (in Cuvier and Valenciennes), 1831: 521 (Vanicolo, Santa Cruz Islands).

Observed occasionally (4 collected) outside the lagoon in 20-35 m. The species is often recorded as *M. auriflamma* or *M. flavolineatus*. Widespread in the tropical Indo-W. Pacific.

*Parupeneus pleurospilos**

Upeneus pleurospilos Bleeker, 1853a: 110 (Ambon).

Two individuals sighted on silty sand bottom in 8 m in Comet's Hole, 1 speared (BPBM 14894, 234 mm SL). Occurs in tropical western Pacific, ranging north to Japan.

Parupeneus pleurostigma

Upeneus pleurostigma Bennett, 1830: 59 (Mauritius).

Upeneus pleurostigma. — Waite, 1901: 37 (Lord Howe Island).

Observed, but none collected in 1973. A single specimen from Lord Howe Island (AMS I. 4686) recorded and figured by Waite (1901). Widespread in the tropical Indo-W. Pacific.

*Parupeneus porphyreus**

Pseudupeneus porphyreus Jenkins, 1903: 454 (Honolulu, Hawaii).

Four specimens collected outside the reef. The caudal peduncle spot is fainter in this species than in *P. signatus*. Widespread in tropical Indo-W. Pacific.

Parupeneus signatus

Upeneus signatus Günther, 1867: 59 (New South Wales).

Hypeneus signatus. — Ogilby, 1889: 56 (Lord Howe Island).

Large schools of juveniles and adults common in the deeper holes in the lagoon. Also observed outside the lagoon down to 30 m. The species is readily distinguished by the black spot dorsally on the caudal peduncle. Doak (1972) recorded this species from New Zealand as *P. porphyreus*. *P. signatus* is closely related to *P. porphyreus*, but has 16 pectoral rays rather than 15. Known from New South Wales, Lord Howe Island, Kermadec Islands, and New Zealand.

*Parupeneus trifasciatus**

Mullus trifasciatus Lacepède, 1802: 383, 404 (no locality given).

Rare, one specimen speared in the lagoon at Comet's Hole. Widespread in the tropical Indo-W. Pacific.

PEMPHERIDAE . . . BULLSEYES (J.R.P.)

Parapriacanthus unwini

Pempheris unwini Ogilby, 1889a: 60 (Lord Howe Island).

Large diurnal schools in caves outside the lagoon in 15-20 m, dispersing at night. Known only from Queensland and Lord Howe Island.

*Pempheris analis**

Pempheris analis Waite, 1910: 375 (Kermadec Islands).

Common outside the lagoon in 5-25 m. Two unrecorded specimens (AMS I. 14066 and IB. 6328) collected in 1917 and 1962 by P. Pedley and J. Booth. The specimens agree with the original description of Waite except the dorsal count is VI, 9-11 rather than VI, 9. Previously recorded from the Kermadec Islands and Western Australia.

*Pempheris oualensis**

Pempheris oualensis Cuvier (in Cuvier and Valenciennes), 1831: 299 (Caroline Islands).

One specimen collected outside the lagoon in 12 m. It lacks enlarged jaw teeth; if *P. otaitensis* is found to be distinct, this latter name should apply. Widespread in the tropical Indo-W. Pacific.

*Pempheris vanicolensis**

Pempheris vanicolensis Cuvier (in Cuvier and Valenciennes), 1831: 305 (Vanicolo, Santa Cruz Islands).

One specimen collected outside the lagoon in 12 m. Three unrecorded specimens (AMS I. 4008-10) from Heron Island, Queensland collected in 1957 by R. Slack-Smith; new record for Australia. Widespread in the tropical Indo-W. Pacific.

KYPHOSIDAE . . . DRUMMERS (D.F.H.)

Girella cyanea

Girella cyanea Macleay, 1881: 409 (no locality, probably New South Wales).

Girella cyanea. — Ramsay, 1888: 32 (Lord Howe Island).

Common in lagoon and outer reef rocky habitats to depths of 25 m, occurring in small aggregations. The angling record for the bluefish for Lord Howe Island is 5 kg. The species has 15 dorsal spines. At the Kermadec Islands it is sympatric with the related *G. fimbriatus*, which has 16 dorsal spines: *G. fimbriatus* is also distinguished by numerous papillae at the margin of the posterior nostril. Known from New South Wales, Middleton and Elizabeth reefs, Lord Howe Island, Norfolk Island, Kermadec Islands, and northern New Zealand.

*Girella elevata**

Girella elevata Macleay, 1881: 408 (Port Jackson, New South Wales).

The blackfish is common in New South Wales, but known from Lord Howe Island from one large adult (AMS I. 13892) collected before 1916. This species differs from *G. cyanea* in being blackish, having a black opercular margin and 13 dorsal spines. Also known from southern Queensland and eastern Victoria.

Kyphosus fuscus

Xyster fuscus Lacepède, 1803: 484-485 (no locality given).

Kyphosus fuscus. — McCulloch and Waite, 1916: 442 (Lord Howe Island).

Five individuals collected outside the lagoon and at Ball's Pyramid in 10-25 m. Others were seen in the lagoon. At Norfolk Island this fish is called the dreamfish; eating the head is said to produce nightmares. Widespread in the Indo-W. Pacific.

SCORPIDIDAE . . . SWEEPS, MADOS AND STRIPEYS (D.F.H.)

Atypichthys latus

Atypichthys latus McCulloch and Waite, 1916: 442-443 (Lord Howe and Norfolk islands).

Common outside the lagoon in 5-40 m. Doak (1972) has illustrated this species from New Zealand as *A. strigatus*. Known from Lord Howe and Norfolk islands and northern New Zealand.

Atypichthys strigatus

Atypus strigatus Günther 1860: 64 (Kermadec Islands and Australia).

Atypus strigatus. — Ramsay, 1888: 32 (Lord Howe Island).

Atypichthys mado Whitley, 1931: 319 (New South Wales).

Whitley (1931), noting that Günther had two species in his description of *A. strigatus*, designated Rauol Island in the Kermadec Islands as the type locality and described the Australian form as *Atypichthys mado*. The Rauol Island specimen belongs to the species described as *Atypichthys latus*. Fraser-Brunner (1946) questioned Whitley's action and designated a skin from Western Australia as the lectotype of *A. strigatus*, making *A. mado* a synonym of *A. strigatus* and leaving *A. latus* for the Kermadec and Lord Howe Island species. Under recent rulings by the International Commission of Zoological Nomenclature designation of a lectotype takes precedence over any type locality designations.

Although Ogilby (1889) reported this species as common in Comet's Hole in the lagoon, we collected only 1 specimen outside the lagoon in 25 m. It was rarely observed in the lagoon. This species is common in New South Wales. Known from Lord Howe Island, New South Wales, Western Australia and possibly New Zealand.

Microcanthus strigatus

Chaetodon strigatus Cuvier (in Cuvier and Valenciennes), 1831: 25 (Japan).

Chaetodon strigatus. — Ogilby, 1889: 55 (Lord Howe Island).

Microcanthus howensis Whitley, 1931: 112-113 (Lord Howe Island).

Observed occasionally (2 collected) in lagoon and outer reef habitats in 2-30 m. Several specimens at AMS, including the type of *M. howensis* (AMS IA. 4018), had previously been collected at Lord Howe Island. The same species occurs from coral reefs at the southern end of the Great Barrier Reef and rocky reefs of New South Wales. Material from New South

Wales show variation of stripe width as well as notable changes with growth. Known from Lord Howe Island, New South Wales, Queensland, Ryukyu Islands, Japan, and the Hawaiian Islands.

Scorpis lineolatus?

Scorpis lineolatus Kner, 1865: 108 (New South Wales).

Scorpis aequipinnis. — McCulloch and Waite, 1916: 443 (in part, one Norfolk Island specimen).

Two specimens at AMS, one from Lord Howe Island (AMS IB. 659) and one from Norfolk Island (AMS I. 6003), are deeper bodied than specimens of *S. violaceus.* In general appearance they agree with *S. lineolatus,* but the gill arches have been removed from both specimens. Known from Lord Howe and Norfolk Islands, and New South Wales.

Scorpis violaceus

Ditrema violacea Hutton, 1873: 261 (New Zealand).

Scorpis aequipinnis. — Ramsay, 1888: 32 (Lord Howe Island).

Observed occasionally (4 collected) outside the lagoon in 3-15 m. This species is distinguished from the related New South Wales form, *S. lineolatus,* in having fewer than 30 rakers on the outer face of the second gill arch. Although *S. violaceus* has been recorded from New South Wales, the specimen could not be located (McCulloch, 1917). As noted by McCulloch and Waite (1916) this species has been confused under the name *S. aequipinnis,* a temperate Australian species. The species figured by Doak (1972) from northern New Zealand as *S. aequipinnis* is clearly not that species, but probably *S. violaceus.* Known from New South Wales, Lord Howe and Norfolk islands, and northern New Zealand.

CHAETODONTIDAE . . . BUTTERFLY FISHES (B.C.R.)

*Chaetodon auriga**

Chaetodon auriga Forsskål, 1775: 60 (Red Sea).

Observed occasionally in the lagoon (also collected) in 1-8 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon bennetti**

Chaetodon bennetti Cuvier (in Cuvier and Valenciennes), 1831: 84 (Sumatra).

Rare, 3 individuals observed (1 collected) in the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon citrinellus**

Chaetodon citrinellus Cuvier (in Cuvier and Valenciennes), 1841: 27 (Guam; Tahiti).

Observed occasionally (also collected) in lagoon and outer reef habitats in 2-15 m, usually associated with rocky substratum. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Chaetodon flavirostris

Chaetodon flavirostris Günther, 1874: 41 (Vavau, Friendly Islands).

Chaetodon aphrodite Ogilby, 1889a: 55 (Lord Howe Island).

Occurs in lagoon and outer reef habitats to 15 m. Second in abundance among species of *Chaetodon*. Goldman (1967) has shown that *C. aphrodite* is the juvenile of *C. flavirostris*. Widespread in the tropical South Pacific including eastern Australia.

*Chaetodon guentheri**

*Chaetodon günther*i Ahl, 1923: 99 (Manado).

Observed occasionally (5 collected) outside the lagoon in 25-45 m. Juveniles infrequently observed in shallow lagoon waters. Known also from eastern Australia, Sulawesi, Taiwan and southern Japan.

*Chaetodon lineolatus**

Chaetodon lineolatus Cuvier (in Cuvier and Valenciennes), 1831: 40 (Mauritius).

About 6 individuals observed (1 collected) in the lagoon in 1-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon lunula**

Pomacentrus lunula Lacepède, 1802: 507, 511-13 (no locality given).

Rare, 1 specimen collected in the lagoon and 2 sighted off Middle Beach. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon melanotus**

Chaetodon melannotus Bloch and Schneider, 1801: 224 (Tranquebar).

Observed occasionally (3 collected) in the lagoon in 1-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon mertensii**

Chaetodon mertensii Cuvier (in Cuvier and Valenciennes), 1831: 47 (no locality given).

Rare, 2 individuals collected outside the lagoon in 25-30 m. Widespread in the tropical western Pacific. Recently collected off Cairns, Queensland by G. Allen; new record for Australia.

*Chaetodon ornatissimus**

Chaetodon ornatissimus Cuvier (in Cuvier and Valenciennes), 1831: 22 (Tahiti).

Recorded here from a colour transparency taken by Mr. J. Brown in the lagoon. Widespread in the tropical western Pacific including Australia.

*Chaetodon pelewensis**

Chaetodon pelewensis Kner, 1867: 308 (Pelew Islands).

Rare, two specimens collected from the lagoon in 1-10 m. Widespread in the tropical western Pacific including Australia.

*Chaetodon plebeius**

Chaetodon plebeius Cuvier (in Cuvier and Valenciennes), 1831: 68 (South Seas).

Observed occasionally (3 collected) in the lagoon in 1-5 m. Widespread in the tropical western Pacific including eastern Australia.

*Chaetodon rainfordi**

Chaetodon rainfordi McCulloch, 1923a: 4 (Holbourne Island, Queensland).

Rare, 2 individuals collected in the lagoon in 1-10 m. Known also from eastern Australia.

*Chaetodon speculum**

Chaetodon speculum Cuvier (in Cuvier and Valenciennes), 1831: 73 (Batavia).

Rare, 2 specimens collected in the lagoon in 1-10 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Chaetodon tricinctus

Chaetodon trincinctus Waite, 1901: 45 (Lord Howe Island).

The most common *Chaetodon* at Lord Howe Island, occurring in lagoon and outer reef habitats in 1-45 m. One specimen from Norfolk Island at AMS (IB. 5356). Confined to Lord Howe and Norfolk islands, and Middleton Reef.

*Chaetodon trifasciatus**

Chaetodon trifasciatus Park, 1797: 34 (Sumatra).

Observed occasionally (4 collected) in the lagoon in 1-10 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon unimaculatus**

Chaetodon unimaculatus Bloch, 1787: 75 (E. Indies).

Rare, 1 pair observed (1 specimen collected) at North Islet in 25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Chaetodon vagabundus**

Chaetodon vagabundus Linnaeus, 1758: 276 (E. Indies).

Rare, 2 specimens collected, 1 from Middle Beach, the other from the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Chelmonops howensis

Chaetodon howensis Waite, 1903: 33 (Lord Howe Island).

Observed occasionally (5 collected) outside the lagoon in 15-45 m. Known also from eastern Australia and northern New Zealand.

*Forcipiger flavissimus**

Forcipiger flavissimus Jordan and McGregor (in Jordan and Evermann), 1898: 1671 (Revillagigedo Archipelago).

Rare, 3 individuals observed (also collected) at North Islet in 20-35 m. Widespread in the tropical Indo-Pacific including eastern Australia.

*Heniochus acuminatus**

Chaetodon acuminatus Linnaeus, 1758: 272 (Indies).

Rare, 1 specimen collected in the lagoon in 3-4 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Megaprotodon trifascialis**

Chaetodon trifascialis Quoy and Gaimard, 1825: 379 (Guam).

Rare, 3 individuals observed by G. Allen in the lagoon in 2 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

POMACANTHIDAE . . . ANGEL FISHES (B.C.R. & J.R.P.)

*Centropyge bispinosus**

Holacanthus bispinosus Günther, 1860: 48 (Ambon; Aneiteum, New Hebrides).

Rare, 1 individual observed (also collected) at North Islet in 25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Centropyge tibicen

Holacanthus tibicen Cuvier (in Cuvier and Valenciennes), 1831: 173 (no locality given).

Holacanthus tibicen. — Ogilby, 1888b: 741 (Lord Howe Island).

Observed occasionally (also collected) in lagoon and outer reef habitats in 2-25 m. Widespread in the western Pacific including eastern Australia.

*Centropyge vrolikii**

Holacanthus vrolikii Bleeker, 1853d: 339 (Ambon).

Rare, 3 individuals observed (1 collected) outside the lagoon in 20-25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Centropyge sp. juv.

Paradiretmus circularis Whitley, 1948: 83 (Lord Howe Island).

The holotype of the nominal genus and species (AMS IB. 1944), is 13 mm SL. The general shape and particularly the head and jaws are strikingly similar to *Diretmus.* However, such fundamental differences as the presence of dorsal and anal spines prompted Whitley (1951a) to propose the new family Paradiretmidae for this form. Since then 2 additional specimens 15-16 mm SL (AMS IB. 4071, IB. 4083) have been collected as beach-strandings near Sydney. The fin counts (D. XIV, 15; A. III, 16; V. I, 5), prominent preopercular spine, head spination, lateral line terminating under the soft dorsal, and ca. 40 scale rows are all characteristic of the pomacanthid genus *Centropyge.* The silvery colouration and small size of this presumably pelagic larval stage does not allow specific determination. The "paradiretmus" larval stage of *Centropyge,* and presumably other pomacanthids, appears homologous to the pelagic "tholichthys" larval stage of chaetodontids and scatophagids, although the lack of prominent head plates and the characteristic head and jaw shape easily distinguish the pomacanthids. Burgess (1974) has recently figured a larval pomacanthid.

Chaetodontoplus conspicillatus

Holacanthus conspicillatus Waite, 1900: 203 (Lord Howe Island).

Observed occasionally (3 collected) off North Islet in 25-35 m. Only 1 individual observed (also collected) in the lagoon in 3 m. Also known from New Caledonia and the Capricorn Group, Queensland.

Genicanthus semicinctus

Holacanthus semicinctus Waite, 1900: 204 (Lord Howe Island).

About 25 individuals observed (several collected) off North Islet in 25-45 m. Males are bluish white on upper part of body with 11 black bars and unmarked light orange on lower part; the dorsal and anal fins are light orange; the lunate caudal fin is spotted with blackish except the lobes which are orange. Juveniles and females are blackish dorsally and bluish-white ventrally with a blue rim around most of eye, the emarginate caudal fin with broad blackish lobes, the central region pale, finely spotted with blackish. Known only from Lord Howe Island.

*Pomacanthus semicirculatus**

Holacanthus semicirculatus Cuvier (in Cuvier and Valenciennes), 1831: 191 (E. Indies).

Rare, 3 individuals observed (1 collected) outside the lagoon in 15-25 m. Widespread in the tropical western Pacific including eastern Australia.

PENTACEROTIDAE . . . BOAR FISHES (G.R.A.)

*Histiopterus acutirostris**

Histiopterus acutirostris Temminck and Schlegel, 1844: 88 (Japan).

Two individuals collected and several others sighted in and around caves and ledges outside the lagoon in 15-30 m. Previously recorded from Japan and Hawaii.

POMACENTRIDAE . . . DAMSEL FISHES (G.R.A.)

Abudefduf coelestinus

Glyphisodon coelestinus Cuvier (in Cuvier and Valenciennes), 1830: 464 (Mauritius).

Glyphisodon coelestinus. — Ogilby, 1889: 64 (Lord Howe Island).

Observed occasionally in the lagoon in 1-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Abudefduf saxatilis

Chaetodon saxatilis Linnaeus, 1758: 276 (Indies).

Glyphisodon saxatilis. — Waite, 1904a: 170 (Lord Howe Island).

Six individuals observed (4 collected) outside the lagoon in 1-5 m. Circumglobal distribution including eastern Australia.

Abudefduf sordidus

Chaetodon sordidus Forsskål, 1775: 62 (Red Sea).

Abudefduf sordidus. — Allen, in press (Lord Howe Island).

Two individuals observed (both collected) in 1 m at north end of lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Amphiprion latezonatus

Amphiprion latezonatus Waite, 1900: 201 (Lord Howe Island).

Observed occasionally on deeper offshore reefs in 25-45 m. Known previously only from the holotype (AMS I. 4349). Our collections contain 11 individuals. Also known from New South Wales and southern Queensland on the basis of unreported specimens recently deposited at AMS.

Amphiprion mccullochi

Amphiprion melanopus. — Ogilby, 1889a (Lord Howe Island).

Amphiprion mccullochi Whitley, 1929: 213 (Lord Howe Island).

Common in the lagoon, also observed in outer reef areas at depths to 45 m. Known only from Lord Howe Island.

Chromis atripectoralis

Chromis atripectoralis Welander and Schultz, 1951: 107 (central and western tropical Pacific).

Chromis atripectoralis. — Allen, in press (Lord Howe Island).

Three individuals observed (also collected) in the lagoon in 3-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Chromis hypsilepis

Heliastes hypsilepis Günther, 1876: 66 (New South Wales).

Heliastes hypsilepis. — Ogilby, 1889a: 66 (Lord Howe Island).

Forms large aggregations outside the lagoon in 5-45 m. Known also from New South Wales, Norfolk Island, and northern New Zealand.

Chromis kennensis

Chromis kennensis Whitley, 1964: 182 (Kenn Reef, Coral Sea).

Chromis kennensis. — Allen, in press (Lord Howe Island).

Small aggregations of juveniles occasionally sighted outside the lagoon in 25 m. Also known from Kenn Reef, New Caledonia, and the Loyalty Islands.

Chromis margaritifer

Chromis dimidiatus margaritifer Fowler, 1946: 140 (Ryukyu Islands).

Chromis margaritifer. — Allen, in press (Lord Howe Island).

One individual observed (also collected) outside the lagoon in 10 m. Widespread in the tropical western Pacific including eastern Australia.

Chromis nitida

Tetradrachmum nitidum Whitley, 1928: 219 (Hayman Island, Queensland).

Chromis nitida. — Allen, in press (Lord Howe Island).

One individual observed outside the lagoon in 10 m. Known previously only from the Great Barrier Reef and New South Wales.

Chromis vanderbilti

Pycnochromis vanderbilti Fowler, 1941: 260 (Hawaiian Islands).

Chromis vanderbilti. — Randall and Swerdloff, 1973: 330 (Lord Howe Island).

Less than 25 individuals were observed outside the lagoon in 20 m. Widespread in the tropical western Pacific including eastern Australia.

Dascyllus aruanus

Chaetodon aruanus Linnaeus, 1758: 275 (Indies).

Dascyllus aruanus. — Allen, in press (Lord Howe Island).

Observed occasionally in rich coral areas of the lagoon in 3-6 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Dascyllus trimaculatus

Pomacentrus trimaculatus Rüppell, 1828: 39 (Red Sea).

Dascyllus trimaculatus. — Allen, in press (Lord Howe Island).

Observed occasionally in lagoon and outer reef habitats in 3-45 m. Frequently commensal with large sea anemones. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Eupomacentrus fasciolatus

Pomacentrus fasciolatus Ogilby, 1889a: 64 (Lord Howe Island).

Abundant in lagoon and outer reef habitats in 1-30 m. Widespread in the tropical western Pacific including eastern Australia. *E. jenkinsi* (Jordan and Evermann), type locality Hawaii, is a junior synonym.

Eupomacentrus gascoynei

Pseudopomacentrus gascoynei Whitley, 1964: 173 (Kenn Reef, Coral Sea).

Eupomacentrus gascoynei. — Allen, in press (Lord Howe Island).

Abundant in lagoon and outer reef habitats in 1-30 m. Reported also from the Great Barrier Reef, New South Wales, and northern New Zealand (Allen, in press).

Glyphidodontops glaucus

Glyphisodon glaucus Cuvier (in Cuvier and Valenciennes), 1830: 475 (Guam).

Glyphidodontops glaucus. — Allen, in press (Lord Howe Island).

One small juvenile collected with rotenone at Ned's Beach (windward side). This species is a dweller of shallow surge areas. Widespread in the tropical western Pacific including eastern Australia.

Glyphidodontops notialis

Glyphidodontops notialis Allen and Randall, 1974: 41 (New South Wales, Lord Howe Island, and New Caledonia).

Abundant outside the lagoon in 7-45 m. Known only from New South Wales, Lord Howe Island, and New Caledonia.

Paraglyphidodon polyacanthus

Glyphidodon polyacanthus Ogilby, 1889a: 65 (Lord Howe Island).

Glyphisodon antjerius (non Cuvier). — Waite, 1904: 170 (Lord Howe Island).

Very abundant in lagoon and outer reef habitats in 1-30 m. Occurs also at the Capricorn Group, Great Barrier Reef (Allen, ms), Norfolk Island, and New Caledonia.

Parma polylepis

Parma polylepis Günther, 1862: 59 (Norfolk Island).

Parma polylepis. — Ogilby, 1889a: 66 (Lord Howe Island).

Abundant in lagoon and outer reef habitats in 1-30 m. Known also from New South Wales, Queensland, Norfolk Island and New Caledonia.

Parma alboscapularis

Parma alboscapularis Allen and Hoese, in press (Lord Howe Island).

Common in certain rocky areas outside the lagoon in 8-15 m. Four specimens collected, including the holotype. Known also from northern New Zealand.

Plectroglyphidodon dickii

Glyphisodon dickii Liénard, 1839: 35 (Mauritius).

Plectroglyphidodon dickii. — Allen, in press (Lord Howe Island).

Several individuals were observed in rich coral areas of the lagoon in 1-5 m. Widespread in the tropical Indo-Pacific including eastern Australia.

Plectroglyphidodon lacrymatus

Glyphisodon lacrymatus Quoy and Gaimard, 1824: 338 (Guam).

Plectroglyphidon lacrymatus. — Allen, in press (Lord Howe Island).

One individual collected in the lagoon at a depth of 2 m. Widespread in the tropical Indo-Pacific including eastern Australia.

Plectroglyphidodon leucozona

Glyphisodon leucozona Bleeker, 1859b: 339 (Java).

Plectroglyphidodon leucozona. — Allen, in press (Lord Howe Island).

One individual speared at Ball's Pyramid in 6 m by G. Allen, but later lost. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Plectroglyphidodon johnstonianus

Plectroglyphidodon johnstonianus Fowler and Ball, 1924: 271 (Johnston Island).

Plectroglyphidodon johnstonianus. — Allen, in press (Lord Howe Island).

Observed occasionally in coralliferous areas of the lagoon and outer reef in 3-15 m. Widespread in the tropical western Pacific including eastern Australia.

Pomacentrus coelestis

Pomacentrus coelestis Jordan and Starks, 1901: 383 (Japan).

Pomacentrus coelestis. — Allen, in press (Lord Howe Island).

Approximately 100 scattered individuals observed outside the lagoon in 5-15 m. Widespread in the tropical western Pacific including eastern Australia.

Pomacentrus pavo

Pomacentrus pavo Bloch, 1787: 6 (E. Indies).

Pomacentrus pavo. — Allen, in press (Lord Howe Island).

None collected in 1973. One specimen (43 mm SL) in the AMS collection (IB. 5674) collected by J. Booth in 1962. Widespread in the tropical Indo-W. Pacific including eastern Australia.

CIRRHITIDAE . . . HAWK FISHES (J.R.P.)

Cirrhitus splendens

Cirrhitichthys splendens Ogilby, 1889a: 58 (Lord Howe Island).

Occasional outside the lagoon in 5-30 m. Known only from Lord Howe Island.

CHIRONEMIDAE . . . KELP FISHES (D.F.H.)

Chironemus marmoratus

Chironemus marmoratus Günther, 1860: 76 (Western Australia).

Chironemus marmoratus. — Ramsay, 1888: 32 (Lord Howe Island).

Known only from 5 specimens (AMS I. 937, I. 7850-51, I. 10636, I. 14067) collected before 1923. Also recorded from Western Australia, New South Wales, and northern New Zealand.

*Chironemus microlepis**

Chironemus microlepis Waite, 1916: 456-457 (Norfolk Island).

Known from 1 specimen from Lord Howe Island (AMS I. 14067) collected in 1917 and the holotype collected at Norfolk Island (AMS I. 5411).

APLODACTYLIDAE . . . ROCK CALES (J.R.P.)

Aplodactylus etheridgi

Haplodactylus etheridgii Ogilby, 1889a: 57 (Lord Howe Island).

Most abundant in shallow rocky areas with rich algal growth in 2-25 m. This species has vomerine teeth (in 2 patches) and 6 branchiostegal rays characteristic of the genus. Norman (1966: 329) erroneously lists the genus as occurring only on the west coast of South America. Known from Norfolk and Lord Howe islands, and recently recorded from northern New Zealand by Doak (1972: Pl. 27) and Moreland (1975).

CHEILODACTYLIDAE . . . MORWONGS (J.R.P.)

Goniistius ephippium

Cheilodactylus (Goniistius) ephippium McCulloch and Waite, 1916: 445 (Lord Howe and Norfolk Islands).

Common in lagoon and outside to 25 m. Previously reported only from Lord Howe and Norfolk islands, but recently recorded from New Zealand by Doak (1972) and Moreland (1975).

Goniistius gibbosus

Chilodactylus gibbosus Richardson, 1841: 21, 102 (Western Australia).

Chilodactylus vittatus (non Garrett, 1864). — Ogilby, 1889a: 59 (Lord Howe Island).

Two specimens collected outside the lagoon in 15-20 m. Two subadults observed at Comet's Hole in the lagoon. Known only from eastern and Western Australia and Lord Howe Island.

MUGILIDAE . . . MULLETS (D.F.H.)
Crenimugil crenilabis

Mugil crenilabis Forsskål, 1775: 73 (Red Sea).

Mugil dobula (non Günther, 1861). — Waite, 1898: 60 (Lord Howe Island).

Oedalechilus cirrhostomus. — Whitley, 1941: 19 (Lord Howe Island).

Crenimugil crenilabis. — Thomson, 1954: 117 (review and Lord Howe Island specimen examined).

This species is known from Lord Howe Island from a single juvenile specimen (AMS I. 4081) upon which the above records are based. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Myxus elongatus

Myxus elongatus Günther, 1861: 466 (Hobson's Bay, Victoria and Port Jackson, New South Wales).

Myxus elongatus. — Ramsay, 1888: 32 (Lord Howe Island).

Six specimens collected in gill nets from the lagoon. The species has been recorded from Norfolk Island as *Cestraeus norfolcensis* Ogilby. Known from New Hebrides, Queensland, New South Wales, Western Australia, Norfolk and Lord Howe islands.

SPHYRAENIDAE . . . BARRACUDAS (J.R.P.)
*Sphyraena barracuda**

Esox barracuda Walbaum, 1792: 94 (W. Indies).

This record is based on 2 photographs in the files of AMS sent by G. Kirby in 1936; the specimen was 4'2" long. Circumglobal distribution including eastern Australia.

*Sphyraena obtusata**

Sphyraena obtusata Cuvier (in Cuvier and Valenciennes), 1829: 350 (Pondicherry, India).

One small specimen collected in the lagoon, others observed swimming in small schools. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Sphyraena waitii?**

Sphyraena waitii Ogilby, 1908a: 29 (Sydney).

One small specimen collected in the lagoon. De Sylva (1974) has indicated the nomenclatural problems in this Indo-Pacific group of barracudas. Possibly widespread in the tropical Indo-W. Pacific including eastern Australia.

LABRIDAE . . . WRASSES (G.R.A.)

*Anampses caeruleopunctatus**

Anampses caeruleopunctatus Rüppell, 1828: 42 (Red Sea).

Observed infrequently (2 collected) outside the lagoon in rocky areas in 3-15 m. Widespread in the tropical Indo-W. Pacific.

Anampses elegans

Anampses elegans Ogilby, 1889a: 67 (Lord Howe Island).

Anampses variolatus Ogilby, 1889a: 67 (Lord Howe Island).

The second most common labrid in the lagoon after *Pseudolabrus luculentus*. Also sighted outside the lagoon to 35 m. Known also from New South Wales and recently recorded from northern New Zealand on the basis of an underwater photograph (Randall, 1972).

Anampses femininus

Anampses twistii (non Bleeker). — Ogilby, 1889a: 67 (Lord Howe Island).

Anampses femininus Randall, 1972: 176 (Easter Island).

Observed infrequently (1 collected) in lagoon and outer reef habitats in 2-35 m. Widespread across southern Oceania from Easter Island to the coast of New South Wales.

*Anampses geographicus**

Anampses geographicus Valenciennes (in Cuvier and Valenciennes), 1839: 8 (no locality given).

One pair observed by J. Randall outside the lagoon in 3 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Anampses neoguinaicus**

Anampses neoguinaicus Bleeker, 1878: 36 (New Guinea).

Less than 12 individuals observed (3 collected) outside the lagoon in 3-10 m. Distributed throughout the tropical western Pacific including eastern Australia.

*Bodianus axillaris**

Labrus axillaris Bennett, 1831: 166 (Mauritius).

One juvenile observed outside the lagoon in a cave by J. Randall in about 8 m. Probably recorded previously from Australia as *B. mesothorax*, a closely related species. Widespread in the tropical Indo-W. Pacific.

Bodianus oxycephalus

Cossyphus oxycephalus Bleeker, 1862: 129 (New Guinea).

Verreo unimaculatus. — Whitley, 1941: 37 (Lord Howe Island).

Several individuals observed outside the lagoon in 30-40 m. One specimen collected at Ball's Pyramid. Widespread in the tropical and subtropical western Pacific including eastern Australia, New Zealand, Easter Island, Hawaii and Japan (M. Gomon, pers. com.).

Bodianus perditio

Labrus perditio Quoy and Gaimard, 1834: 702 (Tonga).

Cossyphus atrolumbus. — Ogilby, 1889a: 66 (Lord Howe Island).

Rare, juvenile and adult specimens collected at North Islet in 30 m. Widespread in the tropical western Pacific including eastern Australia.

*Cheilio inermis**

Labrus inermis Forsskål, 1775: 34 (Red Sea).

Observed occasionally, but not collected in both lagoon and outer reef habitats in 2-30 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Cirrhilabrus sp.*

Several individuals observed in rich coral areas of the lagoon in 2-5 m. Three lots containing 9 specimens, 73-120 mm SL, deposited at AMS and BPBM. The largest lots, AMS I. 17380-004 and BPBM 14899, each contain 4 specimens ranging from 73-120 mm SL. J. Randall is studying the genus.

Coris aygula

Coris aygula Lacepède, 1802: 96 (no locality given).

Coris cingulum. — Whitley, 1927b: 8 (Lord Howe Island).

Rare, 1 juvenile collected and 2 subadults observed outside the lagoon in 10-20 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Coris gaimard**

Julis gaimard Quoy and Gaimard, 1824: 265 (Hawaiian Islands).

Rare, 1 juvenile collected outside the lagoon in 10 m and 1 unreported specimen (AMS B. 9562) taken during the last century. Widespread in the tropical W. Pacific.

Coris picta

Labrus pictus Bloch and Schneider, 1801: 251 (New South Wales).

Coris semicincta Ramsay and Ogilby, 1882: 301 (Lord Howe Island and New South Wales).

Common in both lagoon and outer reef habitats in 1-30 m. Known also from New South Wales and New Zealand.

*Coris sandageri**

Cymolutes sandeyeri Hector, 1884: 323 (New Zealand).

Coris sandageri. — Phillipps, 1927: 41 (name emended).

Small aggregations occasionally observed (11 collected) outside the lagoon in 10-20 m. Doak (1972) has illustrated the different colour forms. Known also from New South Wales and New Zealand.

Coris sp.

Coris aygula (non Lacepède). — Ogilby, 1889a: 68 (Lord Howe Island).

Coris cyanea (non Macleay). — Whitley, 1951b: 401 (Lord Howe Island).

This undescribed species, popularly known as the "doubleheader", was common in both lagoon and outer reef habitats in 1-25 m. Eleven lots containing 14 specimens, 72-365 mm SL deposited at AMS and BPBM. The largest lots, AMS I. 17371-017 and BPBM 14851, each contain 2 specimens, ranging from 80-118 mm SL. Known from Lord Howe Island and New South Wales.

*Cymolutes torquatus**

Xyrichthys torquatus Valenciennes (in Cuvier and Valenciennes), 1839: 54 (E. Indies).

Following Schultz' (1960) key, we identify a 97 mm SL specimen (AMS IA. 2645) collected in 1926 as *C. torquatus*. Widespread in the tropical Indo-W. Pacific.

*Gomphosus varius**

Gomphosus varius Lacepède, 1802: 100 (Tahiti).

Observed occasionally (4 collected) in both lagoon and outer reef habitats in 3-20 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Halichoeres margaritaceus

Julis margaritaceus Valenciennes (in Cuvier and Valenciennes), 1839: 484 (Vanicolo, Santa Cruz Islands).

Platyglossus pseudominiatus. — Ogilby, 1889a: 68 (Lord Howe Island).

Halichoeres opercularis. — Waite, 1900: 202 (Lord Howe Island).

Not uncommon (21 collected) in the lagoon in 2-5 m. Widespread in the tropical western Pacific including eastern Australia.

Halichoeres trimaculatus

Julis trimaculatus Quoy and Gaimard, 1834: 705 (Vanicolo, Santa Cruz Islands).

Platyglossus trimaculatus. — Ogilby, 1889a: 68 (Lord Howe Island).

Observed occasionally (1 collected) in the lagoon in 1-7 m. Widespread in the tropical western Pacific including eastern Australia.

*Hemigymnus fasciatus**

Labrus fasciatus Bloch, 1792: 6 (Japan).

Rare, 1 specimen collected outside the lagoon in 4 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Hemigymnus melapterus**

Labrus melapterus Bloch, 1791: 137 (Japan).

Several observed (1 collected) in coralliferous areas of the lagoon in 3-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Hemipteronotus macrolepidotus**

Labrus macrolepidotus Bloch, 1791: 735 (no locality given).

One specimen (121 mm SL) (AMS I. 7870) from J. Nicholls in 1907. Widespread in the tropical Indo-W. Pacific.

Hemipteronotus pavo

Xyrichthys pavo Valenciennes (in Cuvier and Valenciennes), 1839: 61 (Mauritius).

Iniistius cacatua Waite, 1901: 41 (Lord Howe Island).

One adult female specimen 243 mm SL obtained during the fishing competition. Schultz (in Schultz *et al.*, 1960) distinguished *pavo* from *pavoninus* Valenciennes by the former having 2 to 3 rows of scales on the cheek below the eye instead of the single row of *pavoninus*. J. Randall has examined the holotype of *pavo* at Paris (MNHN A9088, 295 mm SL) and noted that the scales below the ventroposterior edge of the eye occur in a curved diagonal row of 6 scales on one side and a comparable row on the other with a single scale behind this near the top of the first row. He has concluded that *pavo* and *pavoninus* are synonymous. Our specimen has the cheek scale pattern and counts as the holotype of *pavo* (D II-VIII, 12; A III, 12; P. 12; LL 21 + 4; GR 20) and what proportional differences which exist such as shorter pelvic fins may be a function of different size and sex. Widespread in the tropical Indo-W. Pacific.

*Hemipteronotus taeniourus**

Labrus taeniourus Lacepède, 1802: 448 (no locality given).

One specimen (31 mm SL) (AMS IB. 5725) collected by J. Booth in 1962. Widespread in the tropical Indo-W. Pacific.

Hemipteronotus sp.

Novaculichthys jacksonensis (non Ramsay). — Waite, 1900: 202 (Lord Howe Island).

One poorly preserved specimen (AMS I. 3360, 171 mm SL) collected by T. Icely in 1895. It appears close to *H. jacksonensis* (Ramsay) from New South Wales.

Hemipteronotus sp.*

One specimen (BPBM 14758, 69 mm SL) collected on the outer reef on a sandy bottom in 25 m.

Hologymnosus sp.*

Three unidentified individuals clearly belonging to this genus observed by B. Russell and J. Randall at Ball's Pyramid in 30-35 m.

*Labrichthys unilineatus**

Cossyphus unilineatus Guichenot, 1847: 284 (Guam).

Observed occasionally (1 collected) at coralliferous areas of the lagoon in 2-4 m. Previously recorded from Australia as *L. cyaneotaenia*, which Randall and Springer (1973) have shown to be a synonym. Widespread in the tropical Indo-W. Pacific.

*Labroides bicolor**

Labroides bicolor Fowler and Bean, 1928: 224 (Philippine Islands).

Several individuals observed outside the lagoon by G. Allen and J. Randall in 15-25 m. Widespread in the tropical western Pacific.

Labroides dimidiatus

Cossyphus dimidiatus Valenciennes (in Cuvier and Valenciennes), 1839: 136 (Mauritius).

Labroides paradiseus. — Ogilby, 1889a: 67 (Lord Howe Island).

Observed occasionally (1 collected) in both lagoon and outer reef habitats in 2-35 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Lienardella fasciata**

Xiphochilus fasciatus Günther, 1867: 101 (Queensland).

Rare, 1 individual observed outside the lagoon at North Islet in 30 m. Known also from the Great Barrier Reef and New Caledonia.

*Macropharyngodon meleagris**

Julis meleagris Valenciennes (in Cuvier and Valenciennes), 1839: 481 (Ulea).

Observed occasionally (2 collected) outside the lagoon in 10-30 m. Two unreported specimens at AMS from the Capricorn Group, Queensland; new record for Australia. Widespread in the tropical western Pacific including eastern Australia.

*Pseudocheilinus hexataenia**

Cheilinus hexataenia Bleeker, 1857: 84 (Ambon).

Less than 12 individuals observed (2 collected) both in lagoon and outer reef habitats in 2-10 m, usually among live coral. Four specimens at AMS from the Capricorn Group, Queensland; new record for Australia. Widespread in the tropical Indo-W. Pacific.

*Pseudojuloides cerasinus**

Pseudojulis ceracinus Snyder, 1904: 528 (Hawaiian Islands).

Rare, 1 specimen observed (also collected) outside the lagoon at North Islet in 35 m. Known also from the Hawaiian Islands, Tahiti (Randall, 1973) and unreported specimens from the Loyalty Islands and eastern Australia from One Tree Island, Queensland and Byron Bay, New South Wales.

Pseudolabrus gymnogenis

Labrichthys gymnogenis Günther, 1862: 117 and 507 (Sydney).

Pseudolabrus nigromarginatus. — Waite, 1903: 29 (Lord Howe Island).

The single specimen reported by Waite is in the AMS collection (I. 6042); another specimen from Lord Howe Island mentioned by McCulloch (1913) could not be found. Known from Lord Howe Island and eastern Australia.

Pseudolabrus inscriptus

Labrus inscriptus Richardson, 1848: 134 (Norfolk Island).

Labrichthys inscriptus. — Ramsay, 1888: 32 (Lord Howe Island).

Common in lagoon and outer reef habitats, usually in exposed rocky areas with some surge, in 1-10 m. Known also from Norfolk Island, Kermadec Islands, and New Zealand.

Pseudolabrus luculentus

Labrus luculentus Richardson, 1848: 130 (Norfolk Island).

Labrichthys luculentus. — Ramsay, 1888: 32 (Lord Howe Island).

The most abundant labrid in lagoon and outer reef habitats in 1-45 m. Known also from New South Wales, Norfolk Island, Kermadec Islands, and New Zealand.

Pseudolabrus sp.*

Locally common (1 collected, AMS I. 17400-003, 115 mm SL), in sandy areas outside the lagoon in 45 m. The male and female colour varieties were illustrated in colour (plate 38, "rainbow-fish") by Doak (1972) who identified it as *Halichoeres* sp. This new species will be described by A. Ayling and B. Russell. Known also from New Caledonia, N.S.W. and northern New Zealand.

Stethojulis bandanensis

Julis bandanensis Bleeker, 1851: 254 (E. Indies).

Stethojulis axillaris (non Quoy and Gaimard). — Ogilby, 1889a: 68 (Lord Howe Island).

Observed occasionally (7 collected) in lagoon and outer reef habitats in 2-10 m. Widespread in the Indo-Australian Archipelago and tropical western Pacific. Previously recorded from Australia as *S. axillaris.*

*Thalassoma amblycephalus**

Julis amblycephalus Bleeker, 1856a: 83 (Java and Celebes).

Observed occasionally (7 collected) in small aggregations in lagoon and outer reef habitats in 2-15 m. *T. amblycephalus* has only recently been recorded from Australia. Russell et *al.* (1974) include this species as sight records from One Tree Island, Capricorn Group, Queensland. It is common on the Great Barrier Reef and 8 specimens are in AMS. Widespread in the tropical Indo-W. Pacific.

Thalassoma fuscum

Labrus fuscus Lacepède, 1802: 437 (no locality given).

Julis trilobata. — Ogilby, 1889a: 68 (Lord Howe Island).

Observed occasionally (1 collected) in rocky areas with some surge in 1-10 m. Widespread in the tropical Indo-W. Pacific.

Thalassoma hardwickei

Sparus hardwickei Bennett, 1830: 12 (Ceylon).

Thalassoma dorsale. — Waite, 1903: 26 (Lord Howe Island).

Observed occasionally (1 collected) in the lagoon in 2-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Thalassoma janseni

Julis jansenii Bleeker, 1856c: 56 (Celebes).

Thalassoma jansenii. — Waite, 1903: 25 (Lord Howe Island).

Less than 12 individuals observed (1 collected) outside the lagoon in surge areas in 1-5 m. Widespread in the Indo-Australian Archipelago and tropical western Pacific including eastern Australia.

Thalassoma lunare

Labrus lunaris Linnaeus, 1758: 283 (India).

Julis lunaris. — Ogilby, 1889a: 68 (Lord Howe Island).

Common in both lagoon and outer reef habitats in 3-20 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Thalassoma lutescens

Julis lutescens Lay and Bennett, 1839: 65 (Tahiti and Ryukyu Islands).

Thalassoma aneitense. — Waite, 1900: 202 (Lord Howe Island).

Observed occasionally (3 collected) in lagoon and outer reef habitats in 3-20 m. Widespread in the tropical western Pacific including eastern Australia.

Thalassoma purpureum

Scarus purpureus Forsskål, 1775: 27 (Red Sea).

Thalassoma purpureum. — McCulloch and Waite, 1916: 445 (Lord Howe Island).

Observed occasionally (2 collected) in rocky areas with some surge in 1-10 m. Widespread in the tropical Indo-W. Pacific including eastern Australia (latter record based on observation by J. Randall at One Tree Island, Great Barrier Reef).

*Thalassoma quinquevittatum**

Scarus quinquevittatus Lay and Bennett, 1839: 66 (Ryukyu Islands).

Rare, 1 collected outside the lagoon in 3-5 m. Widespread in the tropical western Pacific.

SCARIDAE . . . PARROT FISHES (G.R.A.)

Leptoscarus vaigiensis

Scarus vaigiensis Quoy and Gaimard, 1824: 288 (Waigiu).

Scarichthys auritus. — Ogilby, 1889a: 70 (Lord Howe Island).

Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus chlorodon**

Scarus chlorodon Jenyns, 1842: 105 (Cocos-Keeling Island).

Rare, observed in lagoon and outer reef habitats. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus forsteri**

Scarus forsteri Valenciennes (in Cuvier and Valenciennes), 1839: 275 (Tahiti).

Several individuals observed (4 collected) on the outer reef in 2-20 m. Juveniles occasionally seen in the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Scarus ghobban

Scarus ghobban Forsskål, 1775: 28 (Red Sea).

Scarus sp. Ogilby, 1889a: 70 (Lord Howe Island).

Scarus pyrrhostethus Waite, 1904b: 214 (Lord Howe Island).

Scarids were generally scarce, but this species was the most common; observed in lagoon and outer reef habitats to 30 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus gibbus**

Scarus gibbus Rüppell, 1828: 81 (Red Sea).

Rare, 1 adult collected at Ball's Pyramid in 35 m and juveniles observed in the lagoon at Comet's Hole. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus lunula**

Callyodon lunula Snyder, 1908: 99 (Ryukyu Islands).

Rare, 1 large male observed by J. Randall outside the lagoon in 30 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus sexvittatus**

Scarus sexvittatus Rüppell, 1835: 26 (Red Sea).

Rare, 3 individuals observed (1 collected) outside the lagoon in 3-5 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Scarus sordidus**

Scarus sordidus Forsskål, 1775: 80 (Red Sea).

Less than 12 individuals observed (1 collected) in lagoon and outer reef habitats to 25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Scarus sp.*

Two individuals observed by G. Allen outside the lagoon in 45 m. This undescribed species is apparently confined to deep water. It has also been collected by J. Randall at the Capricorn Group, Queensland and islands of southeast Oceania.

MUGILOIDIDAE . . . GRUBFISHES (B.C.R.)

Parapercis cylindrica

Sciaena cylindrica Bloch, 1792: 42 (E. Indies).

Parapercis cylindrica. — Waite, 1900: 209 (Lord Howe Island).

One collected in 1973, and several specimens previously taken at Lord Howe Island deposited at AMS. Widespread in the tropical western Pacific including eastern Australia.

*Parapercis polyophthalma**

Parapercis polyophthalma Cuvier (in Cuvier and Valenciennes), 1829: 272 (Red Sea).

One specimen from Lord Howe Island taken by J. Booth (AMS IB. 6386). Marshall (1950) has shown that *P. polyophthalma* and *P. hexophthalma* are sexual colour forms of the same species. Widespread in the tropical Indo-W. Pacific.

PERCOPHIDIDAE . . . SAND FISHES (D.F.H.)

Enigmapercis sp.*

This undescribed species was found burrowed in sand outside the southern end of the lagoon in 6-25 m. It will be described by Hoese in a subsequent paper. Four lots containing 18 specimens, 22-60 mm SL, deposited at AMS and BPBM. The largest lot, AMS I. 17358-004, includes 14 specimens, 22-50 mm SL.

LIMNICHTHYIDAE . . . TOMMY FISHES (D.F.H.)

Limnichthys fasciatus

Limnichthys fasciatus Waite, 1904a: 178 (Lord Howe Island).

Abundant in sandy areas of the lagoon and 4 specimens collected outside in 20 m. Also known from Japan, southern Queensland, New South Wales, and Western Australia.

BLENNIIDAE . . . BLENNIES (D.F.H. & B.C.R.)

Cirripectes alboapicalis

Salarias alboapicalis Ogilby, 1899: 742 (Lord Howe Island).

Abundant in coralliferous areas of the lagoon and in surge areas outside the lagoon to depths of 15 m. Several specimens previously collected are at AMS. Schultz (1941) synonymized *C. alboapicalis* with *C. variolosus*. Strasburg and Schultz (1953) recognized the Australian specimens previously identified as *C. variolosus* as *C. filamentosus*, but did not mention *C. alboapicalis*. The species is distinct in having 16 dorsal rays, crenulated lower lip, and in lacking a median nuchal pore. Known from Lord Howe Island, Norfolk Island and the Kermadec Islands.

Cirripectes filamentosus

Salarias filamentosus Alleyne and Macleay, 1877: 337 (Cape York, Northern Australia).

Salarias variolosus. — Ogilby, 1889a: 62 (Lord Howe Island).

One specimen speared in the lagoon at Comet's Hole. This species is common at One Tree Island on the Great Barrier Reef. In these southern specimens the first dorsal spines are not filamentous in females and only slightly prolonged in males. Known from Australia and Lord Howe Island.

Cirripectes sp.*

One specimen (AMS I. 17368-035, 63 mm SL) collected from a surge channel in 4 m outside the lagoon. The species has a similar colour pattern to *C. quagga*, but has higher dorsal ray counts.

Enchelyurus ater

Petroscirtes ater Günther, 1877: 199 (Tahiti).

Enchelyurus ater. — Springer and Gomon, 1975: 78 (Lord Howe Island).

Twenty-seven specimens collected from coral. This is one of the few species taken at Lord Howe Island that is restricted to Oceania. It is replaced on the Great Barrier Reef by the related species *E. kraussi*. Seven specimens collected in 1922 are at AMS.

Entomacrodus striatus

Salarias striatus Quoy and Gaimard (in Cuvier and Valenciennes), 1836: 309-10 (Masson, Mauritius).

Salarias marmoratus. — Ogilby, 1889a: 62 (Lord Howe Island).

Entomacrodus striatus. — Springer, 1967: 73 (Indo-Pacific and Lord Howe Island).

Three specimens collected from rocky high intertidal areas on the western side of the island. Springer (1967) recorded previous AMS specimens collected from Lord Howe Island. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Istiblennius edentulus

Blennius edentulus Bloch and Schneider, 1801: 172 (Society Islands).

Salarias quadricornis. — Ogilby, 1889a: 63 (Lord Howe Island).

Salarias insulae Ogilby, 1899: 741 (Lord Howe Island).

Several specimens collected from rocky intertidal areas. Previously known from Lord Howe Island on the basis of numerous specimens. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Petroscirtes lupus

Salarius lupus De Vis, 1886: 58 (Moreton Bay, Queensland).

Petroscirtes icelii Ogilby, 1894: 370 (Lord Howe Island).

Common (7 collected) in dead heart urchins, cans and bottles over sand in lagoon. Previously known from several specimens. New South Wales and the Great Barrier Reef.

*Plagiotremus laudandus**

Pescadorichthys (Musgravius) laudandus Whitley, 1961: 63 (New Caledonia).

Rare, only 1 specimen collected outside the lagoon off Rabbit Island in 10 m. One unrecorded specimen from One Tree Island, Great Barrier Reef, at AMS; new record for Australia. Widespread in the Indo-W. Pacific including eastern Australia.

*Plagiotremus rhynorhynchos**

Petroskirtes rhynorhynchos Bleeker, 1852a: 273 (Ambon).

Occasional in outer reef habitats from 1-25 m. Widespread in the Indo-W. Pacific including eastern Australia.

*Plagiotremus tapeinosoma**

Petroskirtes tapeinosoma Bleeker, 1857: 64 (Ambon).

Common both in the lagoon and outer reef habitats in 1-25 m. Widespread in the Indo-W. Pacific including eastern Australia and also New Zealand (Doak, 1972: pl. 43 — "*Aspidontus maroubrae*").

*Stanulus talboti**

Stanulus talboti Springer, 1968: 119 (Great Barrier Reef).

Several specimens collected from surge channels and coral ledges in 3-5 m off Phillip Point. Others observed outside the lagoon on coral at depths to 15 m. Previously known only from the Great Barrier Reef.

Xiphasia matsubarai

Xiphasia setifer (non Swainson, 1839). — Waite, 1903: 45 (Lord Howe Island).

Xiphasia matsubarai Okada and Suzuki, 1952: 75-77 (Japan).

Recorded from 1 specimen collected in 1902 (AMS I. 5345). Known only from Lord Howe Island and Japan.

*Xiphasia setifer**

Xiphasia setifer Swainson, 1839: 259 (Vizagapatam, India).

?*Gobioides* sp. Ogilby, 1889a: 62 (Lord Howe Island).

Known from Lord Howe Island on the basis of 1 specimen collected in 1922 (AMS IA. 141). Waite (1903) suggested that the Ogilby (1889) record of *Gobioides* sp. is *Xiphasia setifer*, but the specimen has not been located. Widespread in the tropical Indo-W. Pacific.

TRIPTERYGIIDAE . . . TRIPLEFINS (D.F.H.)

As with the gobiids, this group is in need of revision. Tentatively we use generic names recognized by Australian authors.

Norfolkia squamiceps

Tripterygion nigripenne. — Waite, 1904: 182 (Lord Howe Island).

Gillias squamiceps McCulloch and Waite, 1916: 449 (Lord Howe and Norfolk islands).

Common in lagoon and outer reef habits to depths of 30 m. Previously the species was known from the type (AMS I. 5401) and one additional specimen. Fowler described Norfolk Island specimens as *N. lairdi*. Whitley's (1964) *N. squamiceps* record from the Great Barrier Reef was based on an undescribed species. Known only from Lord Howe and Norfolk islands.

Vauclusella rufopilea

Tripterygion rufopileum Waite, 1904a: 182-84 (Lord Howe Island).

Many specimens collected from shallow parts of the lagoon and inshore windward areas. Whitley (1965) synonymized *V. rufopileum* with *V. annulata*. The species is closely related to *V. annulata* from southern Queensland and New South Wales, but differs in lacking a vertical bar at the base of the caudal peduncle. Males have a reddish head which is black ventrally. That of the females is uniformly yellowish green. Known from Lord Howe and Norfolk islands.

Tripterygiid sp.*

Tripterygion rufopileum Waite, 1904a: 182-84 (in part, Lord Howe Island).

Fifty-three specimens of this banded species collected from the lagoon and east side of the island from intertidal areas to depths of 20 m. Three lots, the largest series 30 specimens 12-25 mm SL (AMS I. 17424-010), deposited at AMS and BPBM.

CLINIDAE . . . CRESTED WEEDFISHES (D.F.H.)

Cristiceps aurantiacus

Cristeceps aurantiacus Castlenau, 1879: 386 (New South Wales).

Cristiceps pedicillatus Ogilby, 1889a: 63 (Lord Howe Island).

Cristiceps australis. — Ogilby, 1890: 1028 (Lord Howe Island).

?*Cristiceps argyropleura.* — Whitley, 1927b: 8 (Lord Howe Island).

Known only from 2 specimens. One (AMS I. 1773) was recorded as *C. aurantiacus* by Ogilby who named it as *C. pedicillatus* in a footnote. The second was recorded as *C. australis* by Waite (AMS I. 2510). No specimens were located to substantiate Whitley's record of *C. argyropleura.* Also known from southern Australia, northward into New South Wales.

Petraites roseus

Cristiceps roseus Günther, 1861: 274 (Western Australia).

Cristiceps roseus. — Ogilby, 1889a: 63 (Lord Howe Island).

Several specimens collected from rocky areas covered with algae in the lagoon and outside in 1-25 m. Also known from Western Australia, South Australia, Victoria, and New South Wales.

AMMODYTIDAE . . . SAND LANCES (D.F.H.)

Ammodytoides vagus

Bleekeria vaga McCulloch and Waite, 1916: 447 (Lord Howe Island).

Known from Lord Howe Island only from the type (AMS I. 9274). Also known from New South Wales.

CALLIONYMIDAE . . . DRAGONETTES (B.C.R.)

*Callionymus calcaratus**

Callionymus calcaratus Macleay, 1881: 628 (Port Jackson, New South Wales).

Rare, 1 specimen collected in the lagoon in 2 m. Known also from western and eastern Australia, and 1 specimen from Norfolk Island (AMS IB. 6411).

Callionymus japonicus scaber

Callionymus japonicus scaber McCulloch, 1926: 197 (Lord Howe Island).

Previously recorded from Lord Howe Island (type locality). Known also from eastern Australia.

GOBIIDAE . . . GOBIES (D.F.H.)

The taxonomy of Indo-Pacific gobiid fishes is in a chaotic state. Many workers have confused 2 or more species under one name. Consequently, it is not possible at this time to give names to all Lord Howe Island species. D. Hoese, who is revising certain gobiid groups, is using a numbering system in some genera which appears below. These numbers will be consistent and given as synonyms in further publications as appropriate names are determined for the species in question.

Acentrogobius sp.*

Several individuals observed (1 collected), AMS I. 17393-002) in the lagoon over sand in 5-10 m. A widespread tropical Indo-W. Pacific species, often confused with *Acentrogobius ornatus*, which is regarded as having the upper pectoral rays free. A re-examination of types is needed to stabilize the nomenclature of this complex.

*Amblygobius phalaena**

Gobius phalaena Valenciennes (in Cuvier and Valenciennes), 1837: 9 (Vanicolo, Santa Cruz Islands).

Several specimens collected from sand at the base of coral slopes in deeper holes in the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Amblygobius sp.*

One specimen 32 mm SL of this pale species collected in the lagoon (AMS I. 17362-019). Others were seen over sand at the base of coral slopes in deeper parts of the lagoon. Also found on the Great Barrier Reef.

*Asterropteryx semipunctatus**

Asterropteryx semipunctatus Rüppell, 1828: 138-139 (Red Sea).

Several individuals observed (2 collected) in the lagoon in the same habitat as *Amblygobius*. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Bathygobius aeolosoma

Gobius aeolosoma Ogilby, 1889a: 61 (Lord Howe Island).

Fourteen specimens collected. The Indo-Pacific species of this genus are in need of revision. The present species differs little from *B. fuscus* from the Great Barrier Reef and may prove to be identical. Known only from Lord Howe Island.

Callogobius sp. 3*

Five specimens collected from coral in the lagoon (AMS I. 17359-016, I. 17362-022, I. 17364-008). It has been recorded from the Great Barrier Reef (McCulloch and Ogilby, 1919) under the name *C. hasselti*, but these workers confused 4 species.

Callogobius sp. 6*

Callogobius sclateri. — McCulloch and Ogilby, 1919: 219 (Two Isles, Great Barrier Reef).

Thirteen specimens collected from coral in the lagoon. It is closest to *C. snelliusi* and *C. irratus*, but has higher fin ray counts. Seven lots deposited at AMS and BPBM; the largest lot 6 specimens 31-51 mm SL, AMS I. 17362-021. Also known from the Great Barrier Reef.

Cottogobius sp.*

Three specimens, 20-21 mm SL collected and several others observed on seawhips in 46 m (AMS I. 17400-002). The species has thickened lower pelvic rays and D. I, 8 and A. I, 9 separating it from *C. yongei* and *C. erythrops*.

Eviota sp.*

One specimen 13 mm SL collected from a rocky area outside the southern end of the lagoon (AMS I. 17363-007). It is in poor condition. It is close to but not identical with *E. nebulosa* Smith.

Eviota sp. cf. *afelei**

Allogobius viridis Waite, 1904a: 177 (in part, Lord Howe Island).

Over 100 specimens collected on live coral in the lagoon and outside the reef in depths to 25 m. The species is green in shallow water and red below about 18 m. It differs from *E. afelei* from the Great Barrier Reef and the central Pacific in having two prominent black spots on the pectoral base, and may prove to be a geographical variant of *E. afelei*. It is similar to *E. queenslandica* from the Great Barrier Reef, which has spots on the pectoral base, but differs in having 6 subcutaneous bars from the anal origin to the caudal base (5 in *E. queenslandica*). Seven lots deposited at AMS and BPBM; the largest lot 80 specimens, 8-22 mm SL (AMS I. 17367-004).

Eviota sp. 4*

Four specimens collected from a surge channel outside the lagoon in 5 m (AMS I. 17424-011). All were pale yellow in life. The species is related to *E. smaragdus*. Specimens are at AMS from Sydney, New South Wales, and the Great Barrier Reef.

Eviota viridis

Allogobius viridis Waite, 1904a: 177 (Lord Howe Island).

This bright green species was found (15 collected) on the reef crest only on coral rubble. It is closely related to *E. zonura* from the central Pacific. Widespread in the tropical western Pacific including eastern Australia.

*Favonigobius lateralis**

Gobius lateralis Macleay, 1881: 602 (southern Australia).

Ten specimens seined from grass flats in the northern part of the lagoon. These have oblique bands, as is typical of specimens from New South Wales. A temperate species ranging from southern Queensland to Tasmania, east to southwestern Australia, and northern New Zealand.

*Fusigobius neophytus**

Gobius neophytus Günther, 1877: 174 (Oceania).

Two specimens collected over sand at the base of coral slopes in deeper holes of the lagoon. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Gnatholepis inconsequens**

Gnatholepis inconsequens Whitley, 1956: 44 (Heron Island, Great Barrier Reef).

Seven specimens collected from the lagoon. This species is similar to *G. anjerensis* and, until a revision is available, the above name is used for this Australian species.

*Paragobiodon echinocephalus**

Gobius echinocephalus Rüppell, 1828: 136 (Red Sea).

One specimen collected, but others in the AMS collection. This species, which is known only from *Pocillopora*, was rare in spite of the abundance of this coral. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Paragobiodon lacunicola**

Paragobiodon lacunicola Kendall and Goldsborough, 1911: 318 (Tuamotu Islands).

This species is closely related to the previous species and also occurs in *Pocillopora*. It too was found to be rare (2 collected). The species is often referred to as *P. kerri*. Widespread in the tropical Indo-W. Pacific including the Great Barrier Reef (new record).

*Paragobiodon xanthosoma**

Gobius xanthosoma Bleeker, 1852b: 703 (Ceram).

This species normally occurs in the coral *Seriatopora hystrix*. Although *Seriatopora* was found to be abundant at Lord Howe Island, only 1 specimen of *P. xanthosoma* was collected. Widespread in the tropical Indo-W. Pacific including the Great Barrier Reef.

*Pleurosicya mossambica**

Pleurosicya mossambica Smith, 1959: 218 (E. Africa).

One specimen collected in 20 m. *Pleurosicya* is related to a group of genera which includes *Cottogobius*, *Bryaninops*, *Pleurosicyops*, and *Luposicya*, which occur on various invertebrates such as alcyonarians, sponges, and ascidians. The species from Lord Howe Island is similar to *P. boldinghi* from New Guinea, but we follow Smith in separating the 2 species. The Lord Howe Island specimen constitutes the first record of the species outside the Indian Ocean.

*Ptereleotris evides**

Encaeura evides Jordan and Hubbs, 1925: 303 (Japan).

Four specimens of this mid-water feeding gobiid collected in about 20 m. This species has been recorded from the Indian Ocean as *P. tricolor*. Unreported specimens at AMS from the Great Barrier Reef; new record for Australia. Widespread in the tropical Indo-W. Pacific.

Quisquilius sp. 3*

One specimen, 31 mm SL collected from a surge channel in 5 m (AMS I. 17417-001). This undescribed species will be treated separately.

Quisquilius sp. 4*

Two specimens, 14-23 mm SL collected 15 m outside the lagoon (AMS I. 17360-013). This undescribed species will be treated in a separate paper revising the genus.

*Valenciennea strigata**

Gobius strigatus Broussonet, 1872: 1 (Tahiti).

A single specimen was speared from 20 m off Phillip Point. Widespread in the tropical Indo-W. Pacific including the Great Barrier Reef.

ACANTHURIDAE . . . SURGEON FISHES (G.R.A.)

*Acanthurus dussumieri**

Acanthurus dussumieri Valenciennes (in Cuvier and Valenciennes), 1835: 201 (Mauritius).

Observed occasionally (1 collected) in the lagoon in 1-6 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Acanthurus mata**

Chaetodon meta (sic) Cuvier, 1829: 224 (no locality given).

Rare, 2 specimens collected in the lagoon in 1-3 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Acanthurus nigrofuscus?**

Chaetodon nigro-fuscus Forsskål, 1775: 64 (Red Sea).

Two individuals, questionably identified as *A. nigrofuscus*, observed outside the lagoon in 25 m by J. Randall. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Acanthurus olivaceus**

Acanthurus olivaceus Bloch and Schneider, 1801: 214 (Tahiti).

One juvenile collected outside the lagoon in 16 m. Widespread in the E. Indies and tropical western Pacific including eastern Australia.

*Acanthurus triostegus**

Chaetodon triostegus Linnaeus, 1758: 274 (Indies).

A school of approximately 75 individuals sighted outside the lagoon in 10 m by G. Allen. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Naso annulatus**

Priodon annulatus Quoy and Gaimard, 1825: 377 (Timor).

One specimen, 47 mm SL collected in the lagoon off Dawson's Point. Widespread in the tropical Indo-W. Pacific, including eastern Australia.

*Naso brevirostris**

Naseus brevirostris Cuvier (in Cuvier and Valenciennes), 1835: 277 (Mauritius, Moluccas, New Guinea).

One specimen collected in the lagoon in 1-4 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Naso herrei**

Naso herrei Smith, 1966: 647 (Philippine Islands).

A single adult observed outside the lagoon in 10 m by J. Randall. Widespread in the tropical W. Pacific.

*Naso hexacanthus**

Priodon hexacanthus Bleeker, 1855a: 421 (Ambon).

A single adult observed outside the lagoon at North Islet in 25 m by J. Randall. Widespread in the tropical Indo-W. Pacific.

Naso unicornis

Chaetodon unicornis Forsskål, 1775: 63 (Red Sea).

Acanthurus unicornis. — Waite, 1900: 207 (Lord Howe Island).

Observed occasionally (1 collected) in lagoon and outer reef habitats in 2-10 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Prionurus maculatus

Prionurus maculatus Ogilby, 1887: 395 (Port Jackson, New South Wales).

Xesurus maculatus. — Waite, 1900: 207 (Lord Howe Island).

Locally common in lagoon and outer reef habitats in 2-30 m. Known from Lord Howe Island and eastern Australia.

*Zebrasoma scopas**

Acanthurus scopas Cuvier (in Cuvier and Valenciennes), 1829: 224 (Banda).

Observed occasionally (2 collected) in rich coralliferous areas of lagoon in 2-8 m. Four unrecorded specimens from Queensland and New South Wales in AMS collection; new record for Australia. Widespread in the tropical Indo-W. Pacific.

ZANCLIDAE . . . MOORISH IDOLS (B.C.R.)

*Zanclus cornutus**

Zanclus cornutus Linnaeus, 1758: 273 (Indies).

Rare, several specimens collected outside the lagoon in 10-15 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

SIGANIDAE . . . SPINEFOOTS (B.C.R.)

*Siganus nebulosus**

Amphacanthus nebulosus Quoy and Gaimard, 1824: 369(Sydney).

One unrecorded specimen (AMS IA. 3793) collected in 1922. Widespread in the Indo-Pacific including eastern Australia.

Siganus sp.*

One specimen (AMS IB. 3285) previously taken at Lord Howe Island in 1955. Woodland (pers. comm.) indicates the specimen may represent a new species, deeper bodied than *S. nebulosus*, which it superficially resembles. More specimens are needed for confirmation.

GEMPYLIDAE . . . BARRACOUTAS AND SNAKE MACKERELS (J.R.P.)

Gempylus serpens

Gempylus serpens Cuvier, 1829: 200 (tropical Atlantic).

Gempylus serpens. — Waite, 1900: 199 (Lord Howe Island).

In addition to the specimen recorded by Waite (AMS I. 3117), one was collected in 1929 (AMS IA. 3796). Tropical and subtropical circumglobal including eastern Australia.

Lepidocybium flavobrunneum

Cybium flavobrunneum Smith, 1849: Pl. 20 (South Africa).

Xenogramma carinatum Waite, 1904a: 158 (Lord Howe Island).

The only Lord Howe Island specimen is the holotype (AMS I. 5599) of Waite's nominal species. Tropical and subtropical circumglobal, including eastern Australia.

Nealotus tripes

Nealotus tripes Johnson, 1865: 434 (Madeira).

Machaerope latispinis Ogilby, 1899: 737 (Lord Howe Island).

Twenty-four specimens in AMS collections, mostly found washed up on Lagoon Beach. Parin and Bekker (1972) have placed in synonymy Ogilby's genus and species, noting a second element in each ventral fin that is present in all the Lord Howe specimens; Iwai and Nakamura (pers. comm.) state the Japanese specimen described by Matsubara and Iwai (1952) also has a small second ventral element. Ogilby's type was registered in the QM. Tropical and subtropical circumglobal, midwater.

SCOMBRIDAE . . . MACKERELS AND TUNAS (B.C.R.)

Acanthocybium solandri

Acanthocybium solandri Cuvier (in Cuvier and Valenciennes), 1832: 141 (Tuamotu Islands).

Acanthocybium solandri. — Whitley, 1964a: 250 (Lord Howe Island).

One specimen caught by a fisherman at Ball's Pyramid during our visit. Circumglobal distribution including eastern Australia.

Katsuwonus pelamis

Scomber pelamis Linnaeus, 1758: 297 (tropical pelagic).

Katsuwonus pelamis. — Whitley, 1964a: 232 (Lord Howe Island).

One specimen (AMS IA. 731) collected in 1922. Widespread in the Indo-Pacific including eastern Australia.

Sarda australis?

Pelamys australis Macleay, 1881: 557 (Port Jackson, New South Wales).

Sarda australis Whitley, 1964a: 236 (Lord Howe Island).

No specimens could be found to substantiate the inclusion of New Guinea and Lord Howe Island on the range map of this species (Whitley, 1964a). According to Collette (pers. comm.), the species is known from southern Queensland to Bass Strait and Norfolk Island.

Scomber australasicus

Scomber australasicus Cuvier (in Cuvier and Valenciennes), 1831: 491 (King Georges Sound, Western Australia).

Pneumatophorus australasicus. — Whitley, 1964a: 248 (Lord Howe Island).

Known also from eastern and western Australia and New Zealand.

Thunnus albacares

Scomber albacares Bonnaterre, 1788: 140 (Madeira).

Neothunnus macropterus. — Whitley, 1964a: 234 (Lord Howe Island).

Circumglobal distribution in tropical and subtropical waters including eastern Australia.

ISTIOPHORIDAE . . . MARLINS AND SAILFISHES (B.C.R.)
Istiophorus platypterus

Xiphias platypterus Shaw and Nodder, 1792: Pl. 8 (Indian Ocean).

Istiophorus ludibundus. — Whitley, 1964a: 245 (Lord Howe Island).

The record of this species from Lord Howe Island is based on a magazine article and photograph (Angler's Digest, December 1960, p. 28 and fig.). Widespread in the Pacific including eastern Australia.

Makaira indica

Tetrapturus indicus Cuvier (in Cuvier and Valenciennes), 1831: 286 (Sumatra).

Istiompax australis. — Whitley, 1944: 254 (Lord Howe Island).

A 100 kg specimen was trolled between Ball's Pyramid and Lord Howe Island by a local fisherman; the specimen was not saved. It carried 2 specimens of *Remora brachyptera.* Widespread in the Indo-Pacific including eastern Australia.

CENTROLOPHIDAE . . . RAFT FISHES (J.R.P.)
Schedophilus maculatus?

Schedophilus maculatus Günther, 1860: 412 (China Sea).

Schedophilus maculatus. — Waite, 1894: 219 (Lord Howe Island).

Five specimens (49-75 mm SL) in AMS collection. Haedrich and Horn (1972) distinguished *S. maculatus* and *S. ovalis* on the basis of vertebrae (29 vs 25), dorsal rays (27-29 vs 31-32) and lower arch gill rakers (13-14 vs 16). All of these specimens have 29 vertebrae and 26-29 dorsal rays, but the lower gill rakers range from 15-16. A paratype (AMS IA. 5565) of Whitley's (1933) *Hoplocoryphis physaliarum* from New South Wales also falls in this range (the holotype has been lost). Southern Ocean (Haedrich and Horn, 1972), including eastern Australia and Kermadec Islands.

*Schedophilus ovalis?**

Centrolophus ovalis Cuvier (in Cuvier and Valenciennes), 1833: 346 (Mediterranean).

One small specimen (AMS IB. 5494) collected in 1962. This specimen has 25 vertebrae, 17 lower gill rakers, but only 26 dorsal rays. Mediterranean, eastern Atlantic, and Australia (Haedrich and Horn, 1972).

NOMEIDAE . . . EYEBROW FISHES (D.F.H.)
Cubiceps baxteri

Cubiceps baxteri McCulloch, 1923a: 15 (Lord Howe Island).

Two specimens are known from Lord Howe Island, the holotype, a 371 mm specimen (AMS IA. 686), and a 285 mm specimen (AMS I. 16150-003). This species differs from C.

caeruleus in having more numerous scale rows on the body (60-62), a broad tongue, a single row of pointed teeth on the tongue and a small patch of pointed teeth on the vomer followed by a single row of small pointed teeth posteriorly. The palatine teeth do not reach the anterior patch of vomerine teeth. Haedrich (1967) suggested that this species might be the adult of *C. caeruleus*. Provisionally we follow McCulloch (1923a) in recognizing *C. baxteri* as distinct from *C. gracilis*; however, a thorough revision of the genus may alter the names used here. Known from Lord Howe Island and New South Wales.

Cubiceps caeruleus?

Cubiceps caeruleus Regan, 1914: 15 (Three Kings Islands, New Zealand).

Cubiceps gracilis. — Waite, 1904a: 162 (Lord Howe Island).

This species is known from the 80 mm (AMS I. 5608) specimen recorded by Waite (1904) and figured by McCulloch (1923a) and a second 180 mm specimen (AMS IA. 1393). The smaller specimen has pointed teeth on the vomer, but the larger has small, knobby, short teeth on the vomer and an oval patch on the tongue. The tongue is pointed, there are few scale rows on the body (48-52), and 21 pectoral rays. The palatine teeth extend forward to beside the oval patch of vomerine teeth. The premaxilla is not covered by the preorbital, as it is in *C. baxteri*. Known from northern New Zealand.

Nomeus gronovii

Gobius gronovii Gmelin, 1789: 1205 (Atlantic Ocean).

Nomeus gronovii.— Waite, 1901: 39 (Lord Howe Island).

Known from Lord Howe Island from 1 specimen (AMS I. 4622). Haedrich (1967) regards the genus as monotypic. Worldwide in temperate and tropical seas.

Psenes pellucidus

Psenes pellucidus Lütken, 1880: 516 (Java).

Caristioides amplipinnis Whitley, 1948: 88 (Lord Howe Island).

Known from Lord Howe Island from the holotype of *Caristioides amplipinnis*, a beach-stranded specimen (AMS IA. 1395). Haedrich (1967) placed this nominal species in the synonymy of *P. pellucidus*. Known from Atlantic, Pacific, and Indian Oceans.

TETRAGONURIDAE . . . SQUARETAILS (D.F.H.)

Tetragonurus atlanticus

Tetragonurus atlanticus Lowe, 1839: 79 (Atlantic Ocean).

Ctenodax wilkinsoni Macleay, 1885: 2 (Lord Howe Island).

Tetragonurus cuvieri. — Waite, 1904b: 201 (Lord Howe Island).

None collected in 1973. This species is known from the type of *Ctenodax wilkinsoni* (AMS I. 5134) and 2 recently collected specimens (AMS I. 16150-002). Grey (1955) listed *wilkinsoni* as a junior synonym of *T. atlanticus*. Worldwide distribution, oceanic.

BOTHIDAE . . . LEFT HANDED FLOUNDERS (D.F.H.)

*Bothus mancus**

Pleuronectes mancus Broussonet, 1782 (Tahiti).

One specimen collected from sand at Middle Beach and is deposited in the Bishop Museum. Widespread in the tropical Indo-W. Pacific.

*Bothus myriaster**

Rhombus myriaster Temminck and Schlegel, 1846: 181 (Japan).

Known from Lord Howe Island on the basis of 1 specimen (AMS I. 1433) taken in 1923. The pectoral fin is slightly shorter than is reported for *B. myriaster*. Known from Japan, Taiwan, and Lord Howe Island.

Bothus pantherinus

Rhombus pantherinus Rüppell, 1831: 121 (Red Sea).

Platophrys pantherinus. — Waite, 1898: 61 (Lord Howe Island).

Five specimens collected from sand, 3 from the lagoon and 1 from 15 m off Phillip Point. Widespread in the tropical Indo-W. Pacific.

Crossorhombus sp.

One specimen (BPBM 14892, 102 mm SL) of this undescribed species collected from Comet's Hole in the lagoon over sand. Three specimens previously collected are at AMS (AMS I. 5386, IA. 2647, IB. 5984).

CYNOGLOSSIDAE . . . TONGUE-SOLES (D.F.H.)

Paraplagusia unicolor

Plagusia unicolor Macleay, 1881: 138 (Port Jackson, New South Wales).

Plagusia unicolor. — Ogilby, 1893: 163 (Lord Howe Island).

This species is known from Lord Howe Island from 2 specimens (AMS IA. 2417 and I. 12096) collected before 1928. Ogilby (1893) recorded it from Lord Howe Island based on a sight record. Known from southern Queensland, New South Wales, and Tasmania.

SOLEIDAE . . . SOLES (D.F.H.)

Aseraggodes haackeanus

Solea (Achirus) haackaena Steindachner, 1883: 95 (South Australia).

Solea ramsayi Ogilby, 1889: 70 (Lord Howe Island).

Two specimens collected from sand outside the lagoon in 5-25 m. Other specimens, including the holotype of *Solea ramsayi* are at AMS. Lord Howe Island and New South Wales specimens have generally been recognized as belonging to the subspecies *A. haackeanus ramsayi*. Insufficient material is currently available to resolve the taxonomic status of the 2 nominal subspecies. Known from southern Australia and Lord Howe Island.

*Aseraggodes macleayanus**

Solea macleayana Ramsay, 1881: 462 (New South Wales).

One specimen at AMS (I. 12664) from Lord Howe Island. Also known from Queensland and New South Wales.

BALISTIDAE . . . TRIGGERFISHES (G.R.A.)

*Balistoides conspicillum**

Balistes conspicillum Bloch and Schneider, 1801: 474 (Indian Seas).

One adult specimen collected in 35 m at Ball's Pyramid. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Rhinecanthus aculeatus**

Balistes aculeatus Linnaeus, 1758: 328 (India).

One specimen from Lord Howe Island (AMS IB. 5728) collected in 1962 by J. Booth. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Rhinecanthus rectangulus**

Balistes rectangulus Bloch and Schneider, 1801: 465 (Indian Ocean).

One specimen from Lord Howe Island (AMS IB. 5711) collected in 1962 by J. Booth. Widespread in the tropical Indo-W. Pacific including eastern Australia.

*Sufflamen chrysopterus**

Balistes chrysopterus Bloch and Schneider, 1801: 266 (Indian Ocean).

A single adult observed in 10 m at Ball's Pyramid by G. Allen. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Sufflamen fraenatus

Balistes fraenatus Latreille, 1804: 74 (Madagascar and Polynesia).

Pachynathus capistratus. — Waite, 1903: 38 (Lord Howe Island).

Observed occasionally (2 collected) in rocky areas outside the lagoon in 10-45 m. Relatively common at Ball's Pyramid. Widespread in the tropical Indo-W. Pacific including eastern Australia.

MONACANTHIDAE . . . LEATHERJACKETS (G.R.A.)

Alutera monoceros

Balistes monoceros Linnaeus, 1758: 327 (near Hong Kong).

Alutera monoceros. — Waite, 1900: 207 (Lord Howe Island).

The 2 specimens recorded by Waite (1900) at AMS (I. 3309-10). Circumglobal distribution including eastern Australia.

Brachaluteres baueri

Aleuterius baueri Richardson, 1846: 68 (coast of Australia).

Brachaluteres baueri. — Waite, 1903: 38 (Lord Howe Island).

We provisionally agree with Waite's (1903) identification. *B. baueri* is a poorly known form described from a drawing. Specimens of *Brachaluteres* at AMS from the New South Wales mainland are identifiable as *B. jacksonianus* (Quoy and Gaimard), previously referred to as *B. trossulus* (Richardson), a junior synonym. It is possible that the Lord Howe Island population represents a geographic colour variant of *jacksonianus* in which the typical

pattern of small spots is replaced by one consisting of a series of narrow longitudinal stripes. The fin ray counts of the Lord Howe Island specimens fall within the normal range for *jacksonianus*.

Cantherines dumerili

Monacanthus dumerilii Hollard, 1854: 361 (Mauritius).

Monacanthus howensis Ogilby, 1889a: 73 (Lord How Island).

Two specimens collected outside the lagoon in 15-35 m. Widespread in the tropical Indo-W. Pacific.

Cantherines longipinnis

Amanses (Cantherines) longipinnis Fraser-Brunner, 1941: 198 (Lord Howe Island).

One specimen collected off North Rock in 25 m. Known previously only from 4 type specimens deposited at AMS. Apparently confined to Lord Howe Island.

*Cantherines pardalis**

Monacanthus pardalis Rüppell, 1835: 57 (Red Sea).

Two specimens collected outside the lagoon in 10-15 m. Widespread in the tropical Indo-W. Pacific. Previously reported from Australia as *C. brunneus*.

Navodon analis

Pseudomonacanthus analis Waite, 1904a: 173 (Lord Howe Island).

Observed occasionally (5 collected) outside the lagoon in 20-40 m. Known only from Lord Howe Island.

Pervagor melanocephalus

Monacanthus melanocephalus Bleeker, 1853b: 95 (Solor).

Monacanthus nitens. — Waite, 1898: 62 (Lord Howe Island).

Canthidermis maculatus or ?*Canthidermis* sp. Ogilby, 1899: 738 (Lord Howe Island).

Monacanthus alternans Ogilby, 1899: 741 (Lord Howe Island and New South Wales).

Observed infrequently (4 collected) outside the lagoon in 15-30 m. Usually seen in pairs. We are unable to locate the Lord Howe Island syntype of *Monacanthus alternans*. However, the New South Wales syntype, a 35 mm SL specimen at AMS, represents the post larval stage of *P. melanocephalus*. Widespread in the E. Indies and tropical western Pacific including eastern Australia.

OSTRACIONTIDAE . . . BOXFISHES (G.R.A.)

Lactoria cornuta

Ostracion cornutus Linnaeus, 1758: 331 (India).

Ostracion cornutus. — Waite, 1903: 37 (Lord Howe Island).

One specimen observed (also collected) in the lagoon in 1-2 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Lactoria fornasini

Ostracion fornasini Bianconi, 1846: 115 (Mozambique).

Ostracion fornasini. — Ogilby, 1889a: 73 (Lord Howe Island).

Paracanthostracion lindsayi levior Whitley, 1933: 105 (Lord Howe Island).

Observed occasionally (1 collected) in the lagoon in 1-2 m. Widespread in the tropical Indo-W. Pacific.

Ostracion cubicus

Ostracion cubicus Linnaeus, 1758: 332 (India).

Ostracion tuberculatum. — Waite, 1900: 207 (Lord Howe Island).

Observed occasionally (4 collected) outside the lagoon in 10-35 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Triorus reipublicae

Lactophrys concatenatus (non Bloch). — Ogilby, 1889a: 73 (Lord Howe Island).

Lactophrys reipublicae Ogilby, 1913: 92 (Australia).

Lord Howe Island specimens at AMS. Reported from New Guinea, Australia, and Lord Howe Island.

TETRAODONTIDAE . . . TOADOS OR PUFFERS (D.F.H. & G.R.A.)

Arothron hispidus

Tetraodon hispidus Linnaeus, 1758: 333 (India).

Tetraodon hispidus. — Ogilby, 1889a: 74 (Lord Howe Island).

One specimen collected in the lagoon. Widespread in the tropical Indo-W. Pacific.

Arothron meleagris

Tetrodon meleagris Lacepede, 1798: 505 (Asia).

Ovoides meleagris. — Waite, 1900: 207 (Lord Howe Island).

Recorded from 2 specimens at AMS. Widespread in the tropical western Pacific.

Arothron stellatus

Tetrodon stellatus Bloch and Schneider, 1801: 503 (Mauritius).

Tetraodon stellatus. — Waite, 1898: 62 (Lord Howe Island).

Four specimens collected between 1898 and 1918 at AMS. Although *A. stellatus* is regarded as having dark spots on the dorsal fin, the Lord Howe Island and Australian specimens lack these markings. *A. stellatus* is also usually recorded as lacking stripes on the belly, but this character is variable in our material. If the spotting of the dorsal fin proves significant, the present specimens will take the name *A. aerostaticus* (Jenyns). Widespread in the tropical Indo-W. Pacific.

Canthigaster callisternus

Tetrodon callisternus Ogilby, 1889a: 74 (Lord Howe Island).

Observed occasionally (16 collected) outside the lagoon in 15-45 m. Juveniles more abundant than adults. Our material includes a 225 mm SL individual, the largest known specimen in this circumtropical genus. Known from New South Wales, Lord Howe Island, Norfolk Island, Kermadec Islands, and northern New Zealand.

*Canthigaster janthinopterus**

Tropidichthys janthinopterus Bleeker, 1855a: 429 (Ambon).

One specimen observed (also collected) outside the lagoon in 25 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Canthigaster valentini

Tetraodon valentini Bleeker, 1853a: 130 (Ambon).

Tetrodon valentini. — Ogilby, 1889a: 74 (Lord Howe Island).

Observed infrequently (4 collected) in both lagoon and outer reef habitats in 2-20 m. Widespread in the tropical Indo-W. Pacific including eastern Australia.

Lagocephalus sceleratus

Tetrodon sceleratus Gmelin, 1788: 1444 (New Caledonia).

Pleuracanthus sceleratus. — Whitley, 1933: 106 (Lord Howe Island).

Recorded from two specimens collected in 1920 and 1922 (AMS IA. 126 and IA. 944). Widespread in the tropical Indo-W. Pacific.

Torquigener altipinnis

Tetrodon altipinnis Ogilby, 1891: 110 (Lord Howe Island).

Known from the holotype (a skin) and one adult in alcohol (AMS I. 127). Ogilby (1891) recorded white spots on the dorsal surface of the body, but the preserved specimen lacks these marks. No other differences are apparent. The specimen was beach-stranded in poor condition. The species has 10 dorsal rays, 8 anal rays, 16 pectoral rays, and pointed dorsal and anal fins. The body spines are weak and extend from between the eyes nearly to the dorsal origin, on the ventral surface from the chin to the anus, and on the sides of the belly and anal fins. The colour is brown or grey, with several white spots dorsally. It is possible that *T. perlevis* (Ogilby) from Queensland is a synonym. This species was previously known only from Lord Howe Island, but specimens from Norfolk Island and New South Wales are deposited at AMS.

Torquigener hamiltoni

Tetraodon hamiltoni Gray and Richardson, 1843: 226 (New South Wales).

Amblyrhynchotus oblongus. — Waite, 1901: 207 (in part, Lord Howe Island juveniles only).

Recorded from 2 specimens from Lord Howe Island collected before 1900 and mentioned by Waite (1901). Also known from Western Australia, South Australia, Victoria, New South Wales, Tasmania, and New Zealand.

Torquigener pleurogramma

Tetrodon pleurogramma Regan, 1903: 300 (New South Wales).

Amblyrhynchotus oblongus. — Waite, 1901: 207 (Lord Howe Island, adults).

Tetraodon hypselogenion. — Waite, 1903: 38 (Lord Howe Island).

Sphaeroides altipinnis. — McCulloch and Waite, 1916: 450 (in part, Lord Howe Island, other than holotype of *T. altipinnis*).

Tetraodon lacrymatus. — Whitley, 1927b: 8 (Lord Howe Island).

Although McCulloch and Ogilby (1916) regarded this species as a synonym of *T. altipinnis*, there are several important differences. *T. pleurogramma* has larger body spines, fewer pectoral rays (14 or 15), and a prominent black or brown stripe on the body and narrow bars under the eye, which are lacking in *T. altipinnis*. Also known from Western Australia, South Australia, New South Wales, and southern Queensland.

DIODONTIDAE . . . PORCUPINE FISHES (G.R.A.)
Chilomycterus orbicularis

Diodon orbicularis Bloch, 1785: 73 (no locality given).

Euchilomycterus quadradicatus Waite, 1900: 208 (Lord Howe Island).

Three specimens at AMS including the holotype of Waite's nominal species (I. 4338). Widespread in the tropical Indo-W. Pacific.

*Diodon holocanthus**

Diodon holocanthus Linnaeus, 1758: 335 (India).

Rare, 1 individual observed outside the lagoon in 25 m by J. Randall. In addition, we examined 2 unreported specimens from Lord Howe Island collected in 1918 (AMS I. 14366-7). Circumglobal distribution including eastern Australia.

Diodon hystrix

Diodon hystrix Linnaeus, 1758: 335 (India).

Diodon hystrix. — Ogilby, 1889a: 74 (Lord Howe Island).

Eight Lord Howe specimens in AMS collection. Circumglobal distribution including eastern Australia.

MOLIDAE . . . SUNFISHES (B.C.R.)
Mola ramsayi

Orthragoriscus ramsayi Giglioli, 1883: 315 (Sydney, New South Wales).

Mola ramsayi. — Whitley, 1933b: 210 (Lord Howe Island).

The only Lord Howe specimen is the juvenile figured by Whitley (AMS IA. 2423). Known also from eastern Australia.

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PHORONIDA FROM AUSTRALIA

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SUMMARY

Five species of Phoronida[2] have been recorded in Australian waters, from the vicinities of Brisbane, Sydney and Melbourne: *Phoronis pallida, P. psammophila, P. australis, Phoronopsis albomaculata* and *Phoronopsis harmeri.* A diagnosis for each species is given, together with notes on their taxonomy and ecology. The descriptions of three species, *Phoronis pallida, P. psammophila* and *Phoronopsis albomaculata,* have been expanded or modified. *Phoronopsis albomaculata* possesses nephridia with a single funnel, not two, and sometimes has a spiral lophophore. A new key to the species of Phoronida is provided, modifying the key established by Emig (1971).

INTRODUCTION

The earliest records of Phoronida in Australian waters were by Haswell (1883, 1885, 1893), from Port Jackson. *Phoronis australis* Haswell, 1883 was described burrowing in the tube wall of cerianthids (Coelenterata: Anthozoa), while a second species, considered to be probably *Phoronis psammophila* Cori, 1889 was recorded growing over empty mussel shells (Haswell, 1893). Other records of Phoronida have been of *P. australis,* from Port Jackson (Benham, 1889) and from Moreton Bay (Ponder, 1971).

An examination of material from recent survey work has increased the number of species of Phoronida known from Australia to five[2]. *Phoronis psammophila* has been definitely identified, and Australian records are now available for *Phoronis pallida* (Schneider, 1862), *Phoronopsis albomaculata* Gilchrist, 1907, and *Phoronopsis harmeri* Pixell, 1912. The occurrences of the five species in Australian waters are discussed below, together with brief descriptions, and a key to the species is provided. Records from Port Phillip Bay, in south-eastern Australia, are given with the station designations used previously (MMBW and FWD, 1973).

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2 Recently a sixth species, *Phoronis muelleri,* has been discovered from Moreton Bay, Queensland.

Records of The Australian Museum, 1977, **Vol. 30 No. 16,** 455-474, Figures 1-6

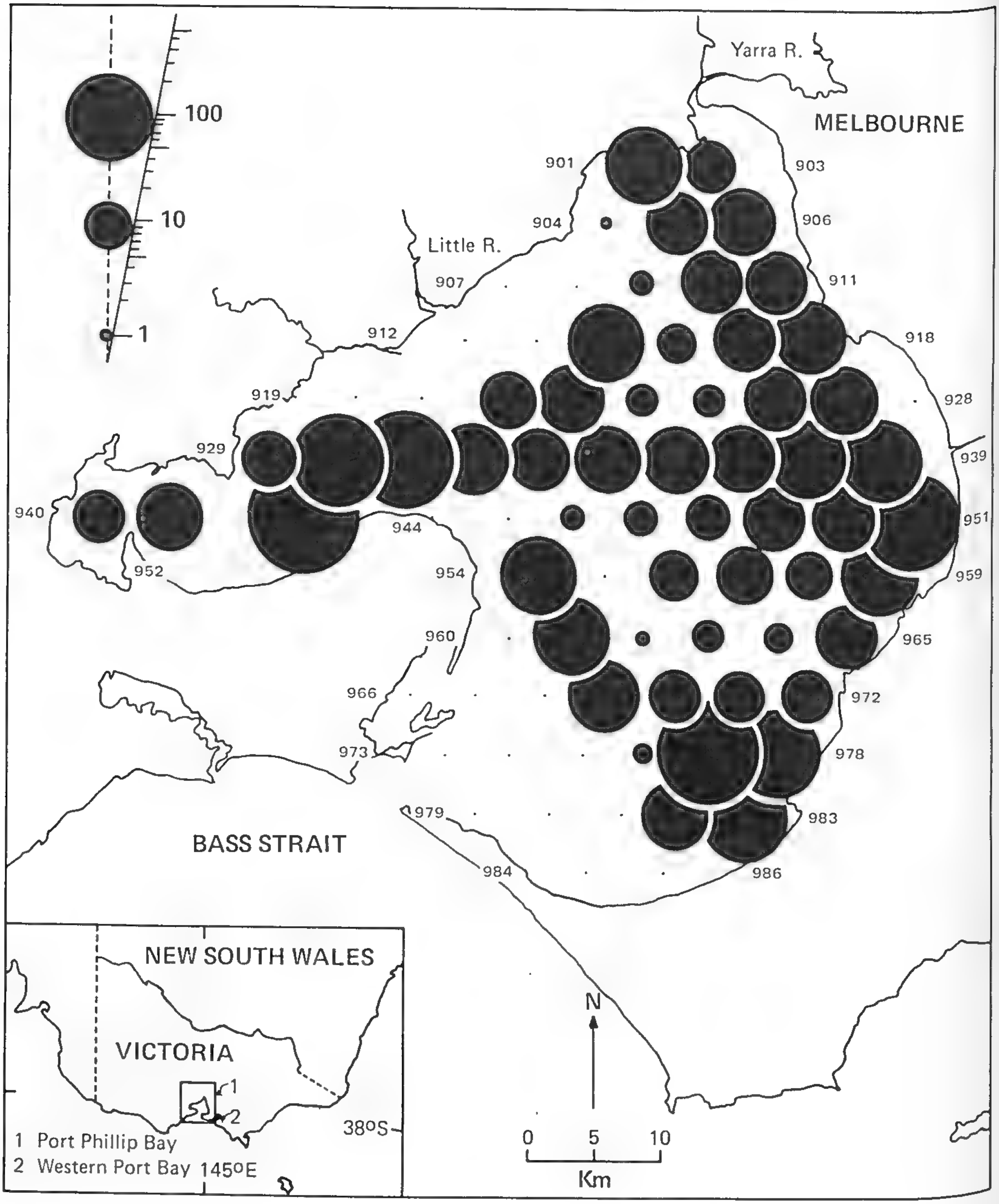

Fig. 1. *Phoronis pallida:* distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.

SYSTEMATICS

Genus **Phoronis** Wright, 1856

Phoronis pallida (Schneider, 1862) Silén, 1952

Figs 1, 2, 7a-f

Phoronis pallida. — Emig, 1969: 1531-1535, figs 2-7.

MATERIAL: Port Phillip Bay (Vict.), — 2515 specimens, from series 0900 between 17 October, 1969, and 11 October, 1971, by Smith-McIntyre grab and diver-operated suction dredge, mainly in fine sediments; — 4 spec., stn 1214, 2 km SE of Yarra River mouth, coll. 9 March, 1971, by grab from silty sediment, 4 m (Australian Museum W6551); — 6 spec., stn 1221, 3.5 km W of stn 1223, coll. 9 March, 1971, by grab from very fine sand, 8 m (Aust. Mus. W6552); — 35 spec., stn 1223, 2 km S of stn 1214, off Yarra River mouth, coll. 9 March, 1971, by grab from very fine sand, 8 m (Aust. Mus. W6553); — 3 spec., stn 1269, 10 km SSW of Werribee River, coll. 11 March, 1971, by grab from fine sand, 8 m (Aust. Mus. W6554).

DIAGNOSIS: Length — up to 140 mm, diameter 0.3-1 mm. Colour — in life, yellowish-pink. Lophophore — horseshoe-shaped (fig. 7a). Tentacles — 50-140, length 2-2.5 mm. Nephridia — with 2 funnels each, anal slightly larger than oral; descending branch nearly as long as ascending branch; nephridiopore on anal papilla, opening at or immediately below level of anus (fig. 7b, d). Giant nerve fibre — on left side only, diameter 10-20 µm (fig. 7f). Longitudinal muscle formula — range [17-19] = $\frac{5\text{-}6}{4} \big| \frac{5}{3\text{-}4}$, mean 18 = $\frac{5}{4} \big| \frac{5}{4}$. Gonads — hermaphrodite (fig. 7e); lophophoral organs large, glandular, nidamental glands absent (fig. 7a, c); no brooding. Larval form — *Actinotrocha pallida.* Other characters — unusual musculature arrangement (fig. 7f, fig. 2); circular muscles present three strong sphincters, longitudinal muscles divide into six zones.

REMARKS: The body length of our fixed specimens of *P. pallida* is 10-30 mm; their extended length should thus reach 100 mm (Emig, 1969a). This compares with lengths of up to 140 mm estimated elsewhere (Emig, 1969b). The tentacles number 80-120 and are about 2 mm long.

The nephridia are typical, with two funnels and the descending branch nearly as long as the ascending branch (Emig, 1969b, 1971). The upper part of the ascending branch is often prominent (fig. 7b, d). The nephridiopore sometimes opens immediately below the anus (fig. 7b).

The diameter of the giant nerve fibre (fig. 7f) ranges from 10 to 18 µm.

Longitudinal muscle bundle formulae were obtained for 104 specimens; the values are as follows, using the conventional formula of Selys-Longchamps (1907): 17 = $\frac{5}{4} \big| \frac{5}{3}$ in 1 specimen; 19 = $\frac{6}{4} \big| \frac{5}{4}$ in 3 specimens; 18 = $\frac{5}{4} \big| \frac{5}{4}$ in all other specimens (fig. 7f). A general muscle formula for *Phoronis pallida* may be given as: [17-19] = $\frac{5\text{-}6}{4} \big| \frac{5}{3\text{-}4}$. The arrangement of longitudinal and circular muscles (fig. 2) is unusual in this species (Silén, 1952; Emig, 1971).

P. pallida is hermaphrodite. A well-developed ovary and testis were present in all specimens examined (fig. 7e). The ovary lies on the dorsal side of the lateral vessel, the testis on the ventral side; the reverse situation found by Silén (1952) and Emig (1969b) was not observed, but the two gonads are often not firmly fixed in relation to each other.

All features examined in our animals agree generally with those specified by Silén (1952) and Emig (1969b, 1971), although the diameter of the giant fibre and the longitudinal muscle bundle numbers have been modified from the diagnosis established by Emig (1974).

In Port Phillip Bay *Phoronis pallida* was found in sediments ranging from fine sand to clayey-silt, occurring in numbers of up to 598 individuals/m^2 in fine sand with an admixture of silt. The tubes built by *P. pallida* tended to reflect the predominant sediment fraction

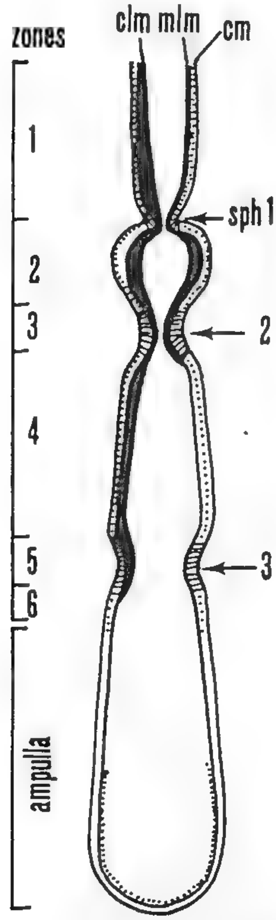

Fig. 2. Arrangement of muscles in *Phoronis pallida* (after Silen, 1952). *clm:* central longitudinal muscles; *cm:* circular muscle; *mlm:* marginal longitudinal muscle; *sph:* sphincter.

present, the walls being covered with fine sand grains and comparatively inflexible in regions of sandy sediment. In all instances, the tube ends immediately below the ampulla in a clear, flexible, membranous bulb free of attached sediment.

Salinities at the bottom in Port Phillip Bay generally range between 34‰ and 36‰. Recorded salinities in 1970-71 for areas where *P. pallida* occurred were 34.1-36.6‰. Lower salinities occur periodically near the mouth of the Yarra R., in the north, at times of flood. A strong salt wedge is usually present in this area, and the occurrence of *P. pallida* near the Yarra mouth may not signify tolerance of salinities markedly below 34‰. Temperatures at the bottom range from 10° to 24°.

No strong relationship with any faunal association is apparent. In general, the distribution of *P. pallida* follows that of surface-deposit feeding molluscs in Port Phillip Bay (Poore and Rainer, 1974).

DISTRIBUTION: Australia — Port Phillip Bay (Vict.); Wider distribution — Pacific and Atlantic oceans (Emig, 1973b).

Figs 7-9.

Abbreviations: *A* ascending branch, *af* anal funnel, *ap* anal papilla, *cf* collar fold, *D* descending branch, *d* diaphragm, e embryos, *ep* epistome, *f* funnel, *i* intestine, *lgf* left giant nerve fibre, *llm* left lateral mesentery, *lo* lophophore, *lv* lateral vessel, *mv* median vessel, *n* nephridiopore, *ng* nidamental glands, *np* nephridial papilla, *o* ovary, *oes* oesophagus, of oral funnel, *ol* lophophoral organs, *pst* prestomach, *rgf* right giant nerve fibre, *rlm* right lateral mesentery, *slv* secondary lateral vessel, *st* stomach, *t* testis.

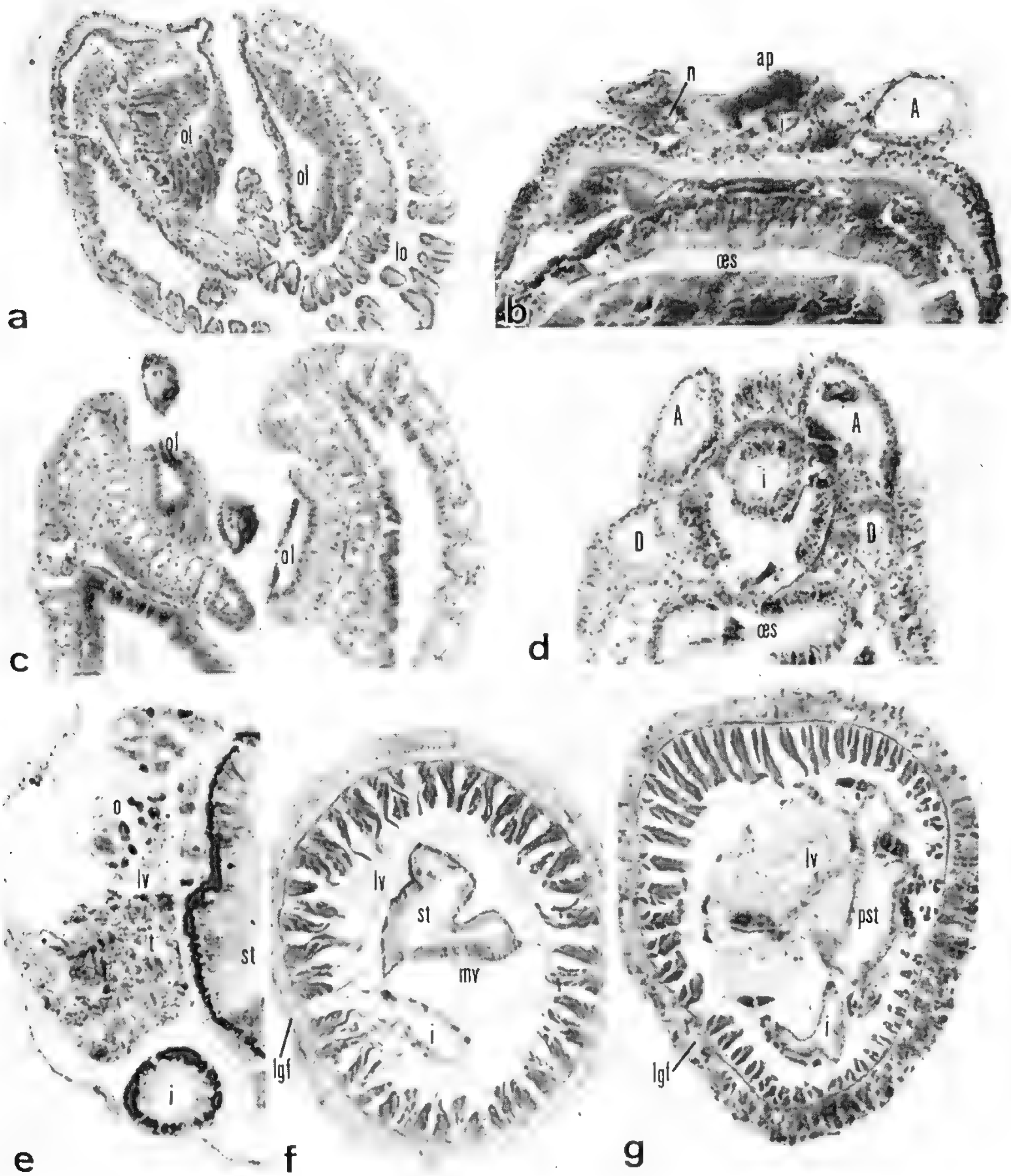

Fig. 7. *Phoronis pallida.* (a) and (c) cross section of the lophophore at the level of the lophophoral organs; (b) cross section of the anal papilla and nephridia; (d) cross section at descending branch of nephridia; (e) cross section of the ampulla through the gonads (testis and ovary); (f) cross section of the muscular region, zone 4. *Phoronis psammophila.* (g) cross section of the muscular region.

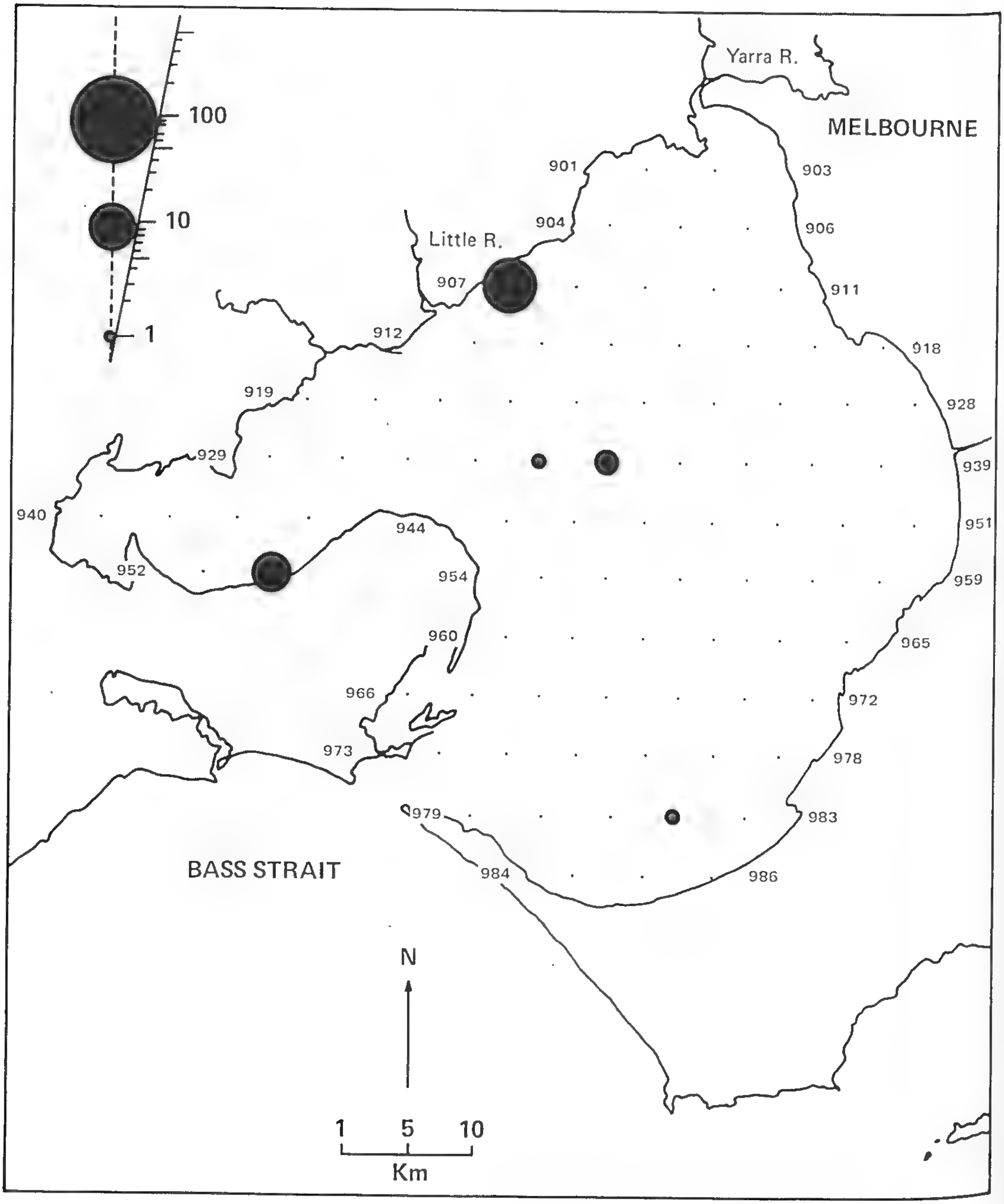

Fig. 3. *Phoronis psammophila*: distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.

Phoronis psammophila Cori, 1889
Figs 3, 7g

Phoronis psammophila. — Emig, 1969a: 312-323 (in part), figs 2-9

Phoronis sabatieri Roule, 1889: 195-196.

Phoronis architecta Andrews, 1890: 445-449, fig. 1.

MATERIAL: Port Phillip Bay (Vict.), — 42 specimens, from series 0900 stations (fig. 3) of Port Phillip Bay Environmental Study, collected between 13 February, 1970, and 3 February, 1972, by Smith-McIntyre grab (S-M) from fine sand or silty sand, 2-25 m; — 6 spec., stn 953, coll. 11 June, 1971, by S-M grab from medium sand, 3 m (Aust. Mus. W6555).

Western Port (Vict.), — 1 specimen, stn 51S, lat. 38°21′22″S, long. 145°13′58″E, coll. 25 March, 1965, by S-M grab from coarse sand, 17 m; — 2 spec., stn M2, lat. 38°22′30″S, long. 145°14′16″E, coll. 7 January, 1974, by S-M grab from coarse sand-gravel sediment, 2 m.

DIAGNOSIS: Length — 60-190 mm, diameter 0.5-2 mm. Colour in life — lophophore transparent with white pigment spots, or occasionally lophophore yellow, red or green; body pink. Lophophore — horseshoe-shaped with ends turned medially. Tentacles — 60-130, length 1.5-2.5 mm. Nephridia — with one funnel each; descending branch short; nephridiopore on anal papilla, opening below anus. Giant nerve fibre — on left side only, diameter 7-27 µm (fig. 1g); rarely, very thin nerve fibre present on right side. Longitudinal muscle formula — range [25-53] = $\frac{7\text{-}19 \mid 7\text{-}17}{4\text{-}11 \mid 4\text{-}11}$, mean 34 = $\frac{11 \mid 11}{6 \mid 6}$. Gonads — dioecious; lophophoral organs large, glandular; nidamental glands of type 2c (after Zimmer, 1964); embryos in one or two masses in lophophore (except probably *P. architecta*); no brooding pattern observed. Larva unknown. Asexual propagation by transverse fission.

REMARKS: The specimens examined agree with the diagnosis of *Phoronis psammophila* given by Emig (1974). Muscle bundle formulae for the Australian material are as follows:

$\frac{11 \mid 11}{6 \mid 6} = 34$; $\frac{11 \mid 12}{7 \mid 6} = 36$; $\frac{13 \mid 13}{7 \mid 6} = 39$; $\frac{14 \mid 13}{7 \mid 6} = 40$; $\frac{13 \mid 12}{8 \mid 7} = 40$; $\frac{13 \mid 14}{7 \mid 7} = 41$; $\frac{13 \mid 13}{8 \mid 7} = 41$;
$\frac{15 \mid 13}{7 \mid 6} = 41$; $\frac{15 \mid 13}{7 \mid 7} = 42$; $\frac{14 \mid 12}{8 \mid 8} = 42$; $\frac{15 \mid 15}{7 \mid 7} = 44$; $\frac{15 \mid 15}{9 \mid 6} = 45$; $\frac{13 \mid 15}{9 \mid 8} = 45$; $\frac{13 \mid 14}{10 \mid 8} = 45$;
$\frac{13 \mid 16}{8 \mid 8} = 45$; $\frac{17 \mid 16}{7 \mid 7} = 47$; $\frac{15 \mid 15}{8 \mid 9} = 47$; $\frac{16 \mid 16}{8 \mid 8} = 48$; $\frac{15 \mid 15}{9 \mid 9} = 48$; $\frac{15 \mid 15}{11 \mid 7} = 48$; $\frac{15 \mid 15}{11 \mid 8} = 49$;
$\frac{16 \mid 17}{9 \mid 7} = 49$; $\frac{15 \mid 17}{9 \mid 9} = 50$; $\frac{16 \mid 16}{9 \mid 9} = 50$ in 4 specimens; $\frac{16 \mid 17}{9 \mid 9} = 51$; $\frac{16 \mid 15}{10 \mid 10} = 51$; $\frac{15 \mid 17}{10 \mid 9} = 51$;
$\frac{15 \mid 16}{11 \mid 10} = 52$; $\frac{17 \mid 16}{10 \mid 9} = 52$; $\frac{18 \mid 16}{10 \mid 8} = 52$; $\frac{15 \mid 17}{10 \mid 10} = 52$; $\frac{17 \mid 17}{9 \mid 9} = 52$; $\frac{15 \mid 16}{11 \mid 11} = 53$; $\frac{19 \mid 17}{7 \mid 10} = 53$.

The general and mean formulae of *Phoronis psammophila* from different localities are compared in Table 1. Significant variations in the mean formula occur from place to place, as previously noted by Emig (1971, 1972), and the present data confirm this. The high upper limit to the number of longitudinal muscle bundles in the Australian material indicates that it belongs to a separate population, as does material from Florida and the Azores (Emig, 1972). The formula given in the diagnosis above represents the limits of variation for the three populations.

The distribution of *P. psammophila* overlapped that of *Phoronis pallida.* (figs 1, 3) although the former species generally occurs in shallower water and coarser sediments. The character of the tube wall varied with sediment in the same way as in *P. pallida*. Salinity and temperature values at the stations where *P. psammophila* occurred are generally similar to those given for *P. pallida*.

A close relationship exists between the distribution of *P. psammophila* and that of *Phoronopsis albomaculata*, at least in Port Phillip Bay (figs 3, 4).

DISTRIBUTION: Australia — Port Phillip Bay, Western Port (Vict.); Wider distribution — cosmopolitan (Emig, 1973b).

Table 1. Comparison of longitudinal muscle bundle formulae of *Phoronis psammophila* in different localities; (a) data published by Emig in other works.

Locality	Number of specimens	Mean formula	General formula
Port Phillip Bay (Australia)	37	$47 = \frac{15}{9}\Big|\frac{15}{8}$	$\frac{11\text{-}19}{6\text{-}11}\Big|\frac{11\text{-}17}{6\text{-}11} = [34\text{-}53]$
Azores (a)	76	$42 = \frac{14}{7}\Big|\frac{14}{7}$	$\frac{12\text{-}19}{5\text{-}9}\Big|\frac{11\text{-}17}{5\text{-}9} = [36\text{-}50]$
Florida (U.S.A.) (a)	38	$40 = \frac{13}{7}\Big|\frac{13}{7}$	$\frac{11\text{-}15}{5\text{-}8}\Big|\frac{11\text{-}17}{5\text{-}9} = [34\text{-}44]$
Concarneau (France) (a)	18	$37 = \frac{12}{7}\Big|\frac{12}{6}$	$\frac{8\text{-}17}{5\text{-}11}\Big|\frac{9\text{-}15}{4\text{-}9} = [26\text{-}46]$
Solomon Islands	4	$37 = \frac{11}{7}\Big|\frac{12}{7}$	$\frac{10\text{-}12}{7\text{-}8}\Big|\frac{11\text{-}12}{6\text{-}9} = [35\text{-}38]$
Chesapeake Bay (U.S.A.)	20	$36 = \frac{12}{6}\Big|\frac{12}{6}$	$\frac{10\text{-}14}{5\text{-}8}\Big|\frac{10\text{-}15}{5\text{-}7} = [32\text{-}42]$
Dinard (France) (a)	30	$36 = \frac{12}{6}\Big|\frac{12}{6}$	$\frac{9\text{-}14}{4\text{-}8}\Big|\frac{9\text{-}15}{4\text{-}8} = [26\text{-}42]$
Nosy-Bé (Malagasy) (a)	9	$35 = \frac{12}{6}\Big|\frac{11}{6}$	$\frac{10\text{-}13}{5\text{-}7}\Big|\frac{10\text{-}12}{5\text{-}6} = [32\text{-}38]$
Gulf of Marseilles (France) (a)	1934	$34 = \frac{11}{6}\Big|\frac{11}{6}$	$\frac{8\text{-}16}{4\text{-}9}\Big|\frac{8\text{-}16}{4\text{-}9} = [26\text{-}46]$
Ivory Coast	5	$34 = \frac{11}{6}\Big|\frac{11}{6}$	$\frac{10\text{-}12}{5\text{-}6}\Big|\frac{11}{6} = [32\text{-}35]$
Etang de Berre (France) (a)	117	$31 = \frac{10}{6}\Big|\frac{10}{5}$	$\frac{8\text{-}13}{4\text{-}7}\Big|\frac{8\text{-}12}{4\text{-}7} = [25\text{-}38]$
Etang de Thau (France) (a)	100	$28 = \frac{9}{5}\Big|\frac{9}{5}$	$\frac{8\text{-}14}{4\text{-}7}\Big|\frac{7\text{-}12}{4\text{-}7} = [25\text{-}39]$
Calanque de Port-Miou (France) (a)	29	$29 = \frac{10}{5}\Big|\frac{9}{5}$	$\frac{8\text{-}11}{4\text{-}6}\Big|\frac{7\text{-}11}{4\text{-}6} = [25\text{-}33]$
Mean of all localities	2417	$34 = \frac{11}{6}\Big|\frac{11}{6}$	$\frac{7\text{-}19}{4\text{-}11}\Big|\frac{7\text{-}17}{4\text{-}11} = [25\text{-}53]$

Phoronis australis Haswell, 1883
Fig. 9d-f.

Phoronis australis. — Emig and Marche-Marchad, 1969: 1244-1250, figs. 2-11.

MATERIAL: Wreck Bay (N.S.W.), lat. 34°60'S, long. 150°E (Aust. Mus. W6016). Camp Cove, Port Jackson (N.S.W.), lat. 33°50'S, long. 151°17'E (Aust. Mus. W6017).

DIAGNOSIS: Biotope — burrowing into tube-wall of cerianthid; an obligate inquiline of cerianthids. Length — 50-200 mm; diameter 2-6 mm. Colour in life — anterior body part black, deep reddish or pink. Lophophore — spiral, with 2.5-3.5 coils on each side (fig. 9d).

Tentacles — 600-1600, length 5-16 mm, tentacles united basally for about one third or one quarter of total length. Nephridia — with 2 funnels each, anal larger than oral, small; no descending branch; nephridiopore on nephridial papilla, opening at or above level of anus (fig. 9e). Giant nerve fibres — paired, diameter of left one 5-13 µm, diameter of right one 3-13 µm (fig. 9f). Longitudinal muscle formula — range [43-87] = $\frac{17\text{-}29 \mid 14\text{-}27}{4\text{-}17 \mid 5\text{-}17}$, mean 66 = $\frac{23 \mid 22}{12 \mid 9}$. Gonads — hermaphrodite; lophophoral organs small; nidamental, of type 2b; embryos brooded on mucous cords. Larva unknown. Asexual propagation by transverse fission.

REMARKS: Some of the material examined was collected near the type locality for the species (Balls Hd, Port Jackson). The Australian specimens generally agree with the description given by Emig and Marche-Marchad (1969), Emig et al. (1972) and Emig (1973a).

The length of the lophophore averages 7-9 mm, somewhat less than the 12-15 mm described by Haswell (1883) and Benham (1889), and the number of tentacles reaches 1600. Two giant fibres are present at all levels, the right slightly smaller than the left, commonly with diameters of 11 and 13 µm respectively. The longitudinal muscle bundle numbers in the Australian specimens are slightly higher than in the formulae established for other localities by Emig (1971, 1973a). The formulae obtained in 21 specimens are as follows:

$\frac{20 \mid 20}{8 \mid 12} = 60$; $\frac{20 \mid 19}{14 \mid 8} = 61$; $\frac{23 \mid 24}{10 \mid 9} = 66$; $\frac{23 \mid 24}{11 \mid 10} = 68$; $\frac{23 \mid 24}{10 \mid 11} = 68$; $\frac{24 \mid 23}{13 \mid 12} = 72$;

$\frac{24 \mid 25}{14 \mid 9} = 72$; $\frac{23 \mid 26}{13 \mid 10} = 72$; $\frac{24 \mid 24}{14 \mid 10} = 72$; $\frac{26 \mid 26}{14 \mid 7} = 73$; $\frac{27 \mid 23}{14 \mid 9} = 73$; $\frac{25 \mid 23}{15 \mid 10} = 73$;

$\frac{23 \mid 24}{14 \mid 12} = 73$; $\frac{25 \mid 22}{17 \mid 9} = 73$; $\frac{24 \mid 25}{14 \mid 11} = 74$; $\frac{27 \mid 22}{13 \mid 13} = 75$; $\frac{25 \mid 27}{13 \mid 11} = 76$; $\frac{27 \mid 23}{14 \mid 12} = 76$;

$\frac{28 \mid 25}{15 \mid 11} = 79$; $\frac{28 \mid 27}{12 \mid 13} = 80$; $\frac{28 \mid 27}{15 \mid 17} = 87$.

The general formula for these specimens is [60-87] = $\frac{20\text{-}28 \mid 19\text{-}27}{8\text{-}17 \mid 7\text{-}17}$ and the mean formula 73 = $\frac{25 \mid 24}{13 \mid 11}$. The different values reported previously by Emig (1971, 1973a) indicate that considerable regional variation exists. The mean and general formulae given in the diagnosis encompass the range of variation so far encountered.

Mature gonads were found in specimens collected at one locality (Camp Cove), in March 1974.

The burrowing habit of *Phoronis australis* is characteristic. Individuals occur in numbers of up to 100 per tube in the tube-wall of *Cerianthus* sp. The material in the present study was collected from mud and muddy sand from 7-13 m deep; the recorded depth range is 0-30 m. Emig et al. (1972) regard the cerianthid tubes as a hard substrate in which *P. australis* burrows, with the ampulla extending into the fourth layer of the cerianthid tube-wall and the lophopore spreading out on the outer surface of the tube. Our present observations agree with this, in contrast to statements made by Ikeda (1903) and Ponder (1971) that the lophophore emerges on the inner surface of the cerianthid tube.

The association between *Phoronis australis* and a cerianthid has been defined by Emig et al. (1972) as an inquilinism.

DISTRIBUTION: Australia — Sydney area, Wreck Bay (N.S.W.), Moreton Bay (Qld.); Wider distribution — Pacific and Atlantic oceans (Emig, 1974).

Genus **Phoronopsis** Gilchrist, 1907
Phoronopsis albomaculata Gilchrist, 1907
Figs 4-6, 8a-g.

Phoronopsis albomaculata. — Emig and Thomassin, 1969: 901-907, figs 2-8.

MATERIAL: Port Thillip Bay (Vict.), — 135 specimens, from series 0900 stations (fig. 4) of Port Phillip Bay Environmental Study, collected between 17 October, 1969, and 3 February, 1972, by Smith-McIntyre grab from fine sand or silty sand, 2-25 m; — 2 spec., stn 1221, 3.5 km W of stn 1223, coll. 9 March, 1971, by S-M grab from very fine sand, 8 m (Aust. Mus. W6556) — 3 spec., stn 1223, 4 km SSE of Yarra R. mouth, coll. 9 March, 1971, by S-M grab from very fine sand, 8 m (Aust. Mus. W6557); — 3 spec., stn 1224, 1.5 km SE of stn 1223, coll. 9 March, 1971, by S-M grab from fine sand, 8 m (Aust. Mus. W6558); — 1 spec., stn 1266, 5 km SE of Werribee R., coll. 11 March, 1971, by S-M grab from fine sand, 8 m (Aust. Mus. W6559).

Western Port (Vict.), — 1 spec., stn 22N, lat. 38°20'36"S, long. 145°13'12"E, coll. 18 March 1965 by S-M grab from shelly sand, 13 m.

Brisbane River (Qld), fig. 5 (Aust. Mus. W6024).

DIAGNOSIS: Length — 80-150 mm, diameter, 0.5-2 mm. Colour in life — lophophore pigmented with white spots; body yellowish. Lophophore — horseshoe-shaped or spiral, with a single coil on each side (fig. 8a, c). Tentacles — 70-160, length 2-3 mm. Nephridia — with one funnel each; descending branch short; epithelium thick; nephridiopore on anal papilla, opening below level of anus, on collar fold within invagination (figs. 6, 8b, d, g). Giant nerve fibre — paired, left fibre only present below nephridial level, left fibre diameter 15-35 µm (fig. 8e). Longitudinal muscle formula — range $[46\text{-}102]\frac{4\text{-}33}{7\text{-}20}\Big|\frac{15\text{-}33}{7\text{-}16}$, mean $71 = \frac{23}{14}\Big|\frac{22}{12}$. Gonads — dioecious; lophophoral organs more or less glandular; no nidamental glands observed (fig. 8c). Larva unknown. Asexual propagation by transverse fission. Invagination — about 0.1 mm deep, often not distinct on oral side (fig. 8b, d, g).

REMARKS: The present material is distinct in a number of features considered diagnostic by Emig (1972, 1974).

The lophophore is horseshoe-shaped, with the ends turned inwards to form a single-coiled spiral on each side (fig. 8a). The number of tentacles reaches 160.

The nephridia possess only a single funnel (fig. 6, 8b, d, g), not two as suggested by Emig and Thomassin (1969) and Emig (1971). They are very similar to the nephridia of *Phoronis psammophila,* differing only in the larger size of the nephridial branches and in the position of the nephridiopore on the collar fold within the invagination in *Phoronopsis albomaculata* (fig. 7b, d). In both species the lateral mesenteries are lacking between the nephridial funnel and the diaphragm (fig. 8b, d, g). Accordingly, using the phoronid nephridial types established by Emig (1971, 1974), the nephridia of *Phoronopsis albomaculata* do not belong to category 5, but rather to category 2, and have the characteristics given in the diagnosis.

The diameter of the left giant nerve fibre averages 20-35 µm (fig. 8e).

Longitudinal muscle formulae were obtained for 14 specimens from Port Phillip Bay and 18 specimens from Brisbane River.

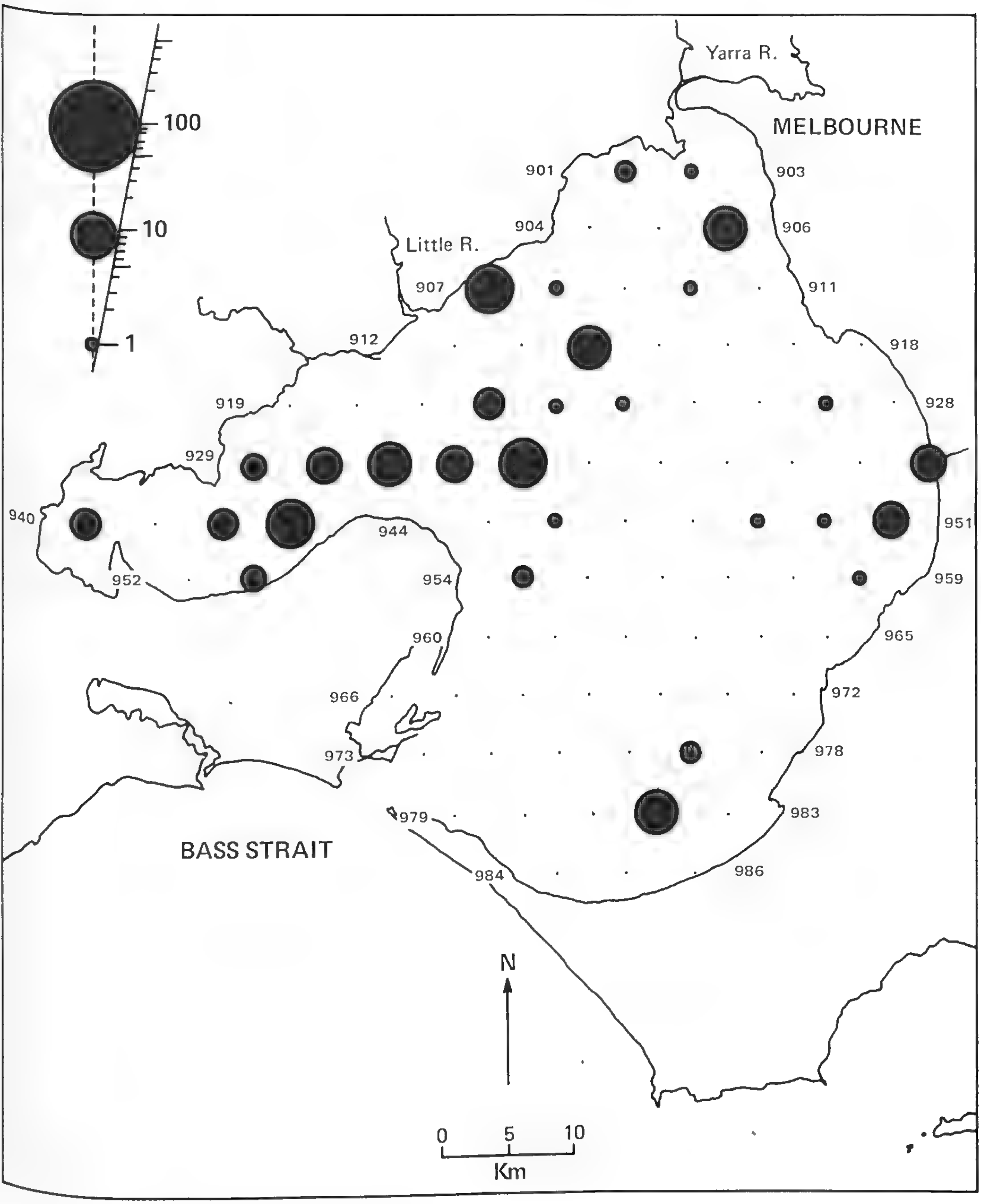

Fig. 4. *Phoronopsis albomaculata*: distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.

Port Phillip Bay: $\frac{14 \mid 15}{8 \mid 9} = 46$; $\frac{18 \mid 18}{7 \mid 8} = 51$; $\frac{17 \mid 18}{10 \mid 7} = 52$; $\frac{17 \mid 18}{11 \mid 8} = 54$; $\frac{19 \mid 18}{10 \mid 11} = 58$; $\frac{19 \mid 20}{10 \mid 10} = 59$; $\frac{19 \mid 20}{11 \mid 9} = 59$; $\frac{19 \mid 20}{11 \mid 10} = 60$; $\frac{23 \mid 19}{10 \mid 10} = 62$; $\frac{22 \mid 20}{11 \mid 10} = 63$; $\frac{21 \mid 21}{11 \mid 10} = 63$; $\frac{21 \mid 21}{13 \mid 9} = 64$; $\frac{22 \mid 23}{11 \mid 11} = 67$; $\frac{20 \mid 24}{11 \mid 13} = 68$.

Brisbane R.: $\frac{19 \mid 19}{12 \mid 12} = 62$; $\frac{21 \mid 20}{14 \mid 12} = 67$; $\frac{21 \mid 21}{14 \mid 13} = 69$; $\frac{22 \mid 20}{14 \mid 13} = 69$; $\frac{25 \mid 22}{14 \mid 12} = 73$; $\frac{24 \mid 21}{16 \mid 15} = 76$; $\frac{25 \mid 23}{15 \mid 13} = 76$; $\frac{26 \mid 24}{15 \mid 13} = 78$; $\frac{25 \mid 23}{16 \mid 14} = 78$; $\frac{28 \mid 24}{16 \mid 15} = 83$; $\frac{27 \mid 28}{15 \mid 13} = 83$; $\frac{28 \mid 25}{17 \mid 15} = 85$; $\frac{28 \mid 27}{16 \mid 14} = 85$; $\frac{26 \mid 26}{17 \mid 16} = 85$; $\frac{30 \mid 26}{14 \mid 16} = 86$; $\frac{31 \mid 27}{17 \mid 13} = 88$; $\frac{31 \mid 28}{16 \mid 14} = 89$; $\frac{33 \mid 33}{20 \mid 16} = 102$.

Table 2. Comparison of longitudinal muscle bundle formulae of *Phoronopsis albomaculata* in different localities; (a): see Emig (1973a).

Locality	Number of specimens	Mean formula	General formula
Brisbane River (Australia)	18	$79 = \frac{26 \mid 24}{15 \mid 14}$	$\frac{19\text{-}33 \mid 19\text{-}33}{12\text{-}20 \mid 12\text{-}16} = [62\text{-}102]$
Tulear (Malagasy) (a)	18	$74 = \frac{23 \mid 24}{14 \mid 13}$	$\frac{20\text{-}30 \mid 21\text{-}27}{11\text{-}18 \mid 10\text{-}15} = [67\text{-}82]$
Nosy-Mitsio (Malagasy) (a)	10	$69 = \frac{22 \mid 21}{14 \mid 12}$	$\frac{20\text{-}25 \mid 19\text{-}24}{11\text{-}17 \mid 10\text{-}14} = [61\text{-}79]$
Nosy-Bé (Malagasy) (a)	5	$67 = \frac{21 \mid 20}{14 \mid 12}$	$\frac{18\text{-}23 \mid 17\text{-}22}{12\text{-}15 \mid 11\text{-}13} = [59\text{-}73]$
Ivory Coast (a)	1	$66 = \frac{21 \mid 19}{12 \mid 14}$	$\frac{21 \mid 19}{12 \mid 14} = [66]$
Port Phillip Bay (Australia)	14	$61 = \frac{20 \mid 20}{11 \mid 10}$	$\frac{14\text{-}23 \mid 15\text{-}24}{7\text{-}13 \mid 7\text{-}13} = [46\text{-}68]$
Mean of all localities	66	$71 = \frac{23 \mid 22}{14 \mid 12}$	$\frac{14\text{-}33 \mid 15\text{-}24}{7\text{-}20 \mid 7\text{-}16} = [46\text{-}102]$

General and mean formulae extend the range of values reported previously for *Phoronopsis albomaculata* (Table 2), and the diagnostic muscle formulae take the new values into account.

Previous observations (Emig, 1973a) that *Phoronopsis albomaculata* is dioecious, has large and more-or-less glandular lophophoral organs (fig. 8c), and seems to lack nidamental glands, are confirmed on the Brisbane R. material (the Port Phillip Bay specimens were not in breeding condition). The absence of nidamental glands suggests that brooding does not occur. As in *Phoronopsis californica* and sometimes in *Phoronis psammophila* (Emig, 1973a), the testis occurs both along the lateral vessel in the left oral cavity of the trunk coelom and along the secondary lateral vessel in the right oral cavity (fig. 8f).

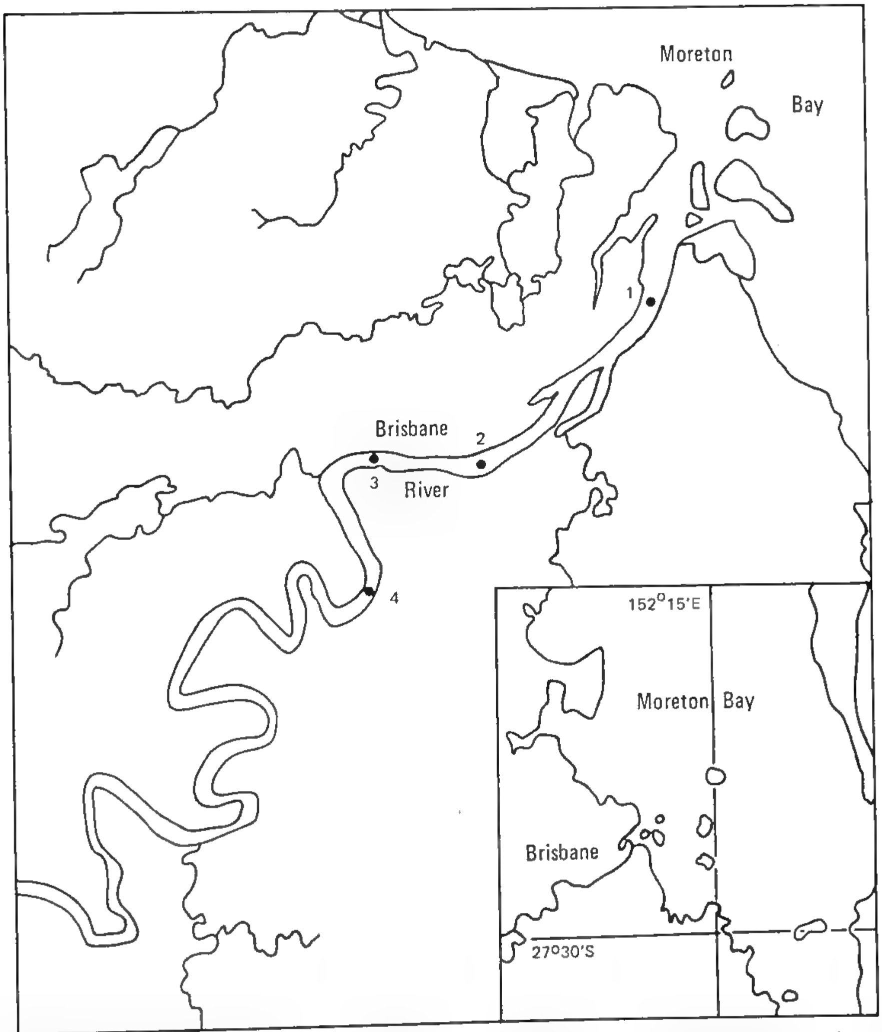

Fig. 5. Brisbane River and Moreton Bay: localities at which *Phoronopsis albomaculata* and *Phoronis australis* (Ponder, 1971) have been found. (1. Quarantine Station; 2. Meeandah; 3. Bulimba; 4. New Farm Park.)

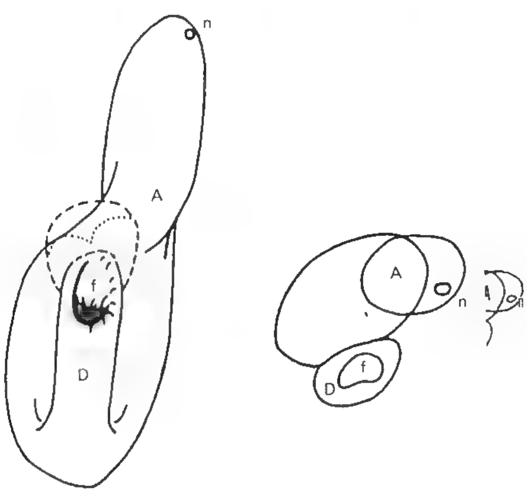

Fig. 6. Diagram of a nephridium of *Phoronopsis albomaculata*. The dotted line indicates the possible extent of funnel development that may occur, especially during gonad maturation (cf. Emig, 1971). Abbreviations, see figs 7-9.

In Port Phillip Bay *Phoronopsis albomaculata* has a distribution very similar to that of *Phoronis psammophila,* although more extensive (fig. 4), occurring in a density of up to 30 individuals/m^2 in silty-sand. It is subject to the same range of water temperature and salinity, and has the same depth range (2-25 m). The tube is similar to that of *P. psammophila.*

Some difficulty was experienced in differentiating *Phoronopsis albomaculata* from *Phoronis psammophila,* due to their similar general morphology and overlapping longitudinal muscle formulae. The invagination diagnostic of the genus *Phoronopsis* is often imperfectly developed in specimens that have recently undergone asexual propagation, or are regenerating the lophophore for any other reason. Such specimens were found at most stations, but any misidentification that may have occurred would not influence the general pattern of distribution as illustrated in figure 4.

In the estuary of the Brisbane River (fig. 5), *Phoronopsis albomaculata* was found subtidally as far upstream as New Farm Park, 22 km from the mouth, but was most abundant (up to 272/m^2) at the Quarantine Station site, 7 km from the mouth. Sediments at these sites ranged from muddy-sand at Quarantine Station to very soft mud at Bulimba and New Farm Park. Salinity at Quarantine Station is about 34‰ during much of the year, but dropped to 27‰ in December, 1971, and to 10‰ in February, 1972, following a flood caused by passage of a cyclone. At New Farm Park salinity is about 30‰ during low-flow conditions, but became near 0‰ in February, 1972. No *Phoronopsis albomaculata* were found above Quarantine Station just after the flood. The annual temperature range in the Brisbane River is approximately 16-28°. Benthic invertebrates associated with *Phoronopsis albomaculata* in the Brisbane River include the polychaetes *Prionospio* sp., *Heteromastus filiformis, Notomastus* sp., *Owenia fusiformis* and *Potamilla* sp; the bivalve *Notospisula parva,* the tanaid *Apseudes estuarius* and the amphipod *Eriopisa australiensis.*

DISTRIBUTION: Australia — Port Phillip Bay, Western Port (Vict.), Brisbane River (Qld); Indian and Atlantic oceans (Emig, 1973b).

Phoronopsis harmeri Pixell, 1912
Fig. 9a-c.

Phoronopsis harmeri. — Emig, 1967: 984-989, figs 1-4

Phoronis pacifica Torrey, 1901: 283-288, figs 1-5.

Phoronopsis viridis Hilton, 1930: 33-34, figs 1-4.

Phoronopsis striata Hilton, 1930: 34-35, figs 5-9.

MATERIAL: Careel Bay, Pittwater (N.S.W.), north of Sydney, lat. 151°20′E, long. 33°38′S (Aust. Mus. W6018, W6019, W6020, W6021, W6022, W6023).

Wallis Lake (N.S.W.), north of Port Stephens, lat. 152°35′E, long. 32°15′S (Aust. Mus. W4332).

DIAGNOSIS: Length — 40-220 mm, diameter 0.6-4 mm. Colour in life — greenish with white-pigmented tentacles. Lophophore — spiral, with 1.5-2 coils on each side. Tentacles — 100-400, length 2-5 mm. Nephridia — with two funnels each, anal smaller than oral (fig. 3b); long descending branch; nephridiopore opening on collar fold in invagination, below level of anus (fig. 3a). Giant nerve fibres — paired, diameter of left one 20-60 µm (fig. 3c); right giant nerve fibre present above level of right nephridium, atrophied below. Longitudinal muscle formulae — range [75-138] = $\frac{20\text{-}48 \mid 23\text{-}55}{12\text{-}27 \mid 11\text{-}26}$, mean 111 = $\frac{37 \mid 36}{20 \mid 18}$. Gonads — dioecious; lophophoral organs large, membranous; nidamental glands absent; no brooding pattern. Larval form — *Actinotrocha A* (Zimmer, 1964). Invagination — very distinct (fig. 9a, b).

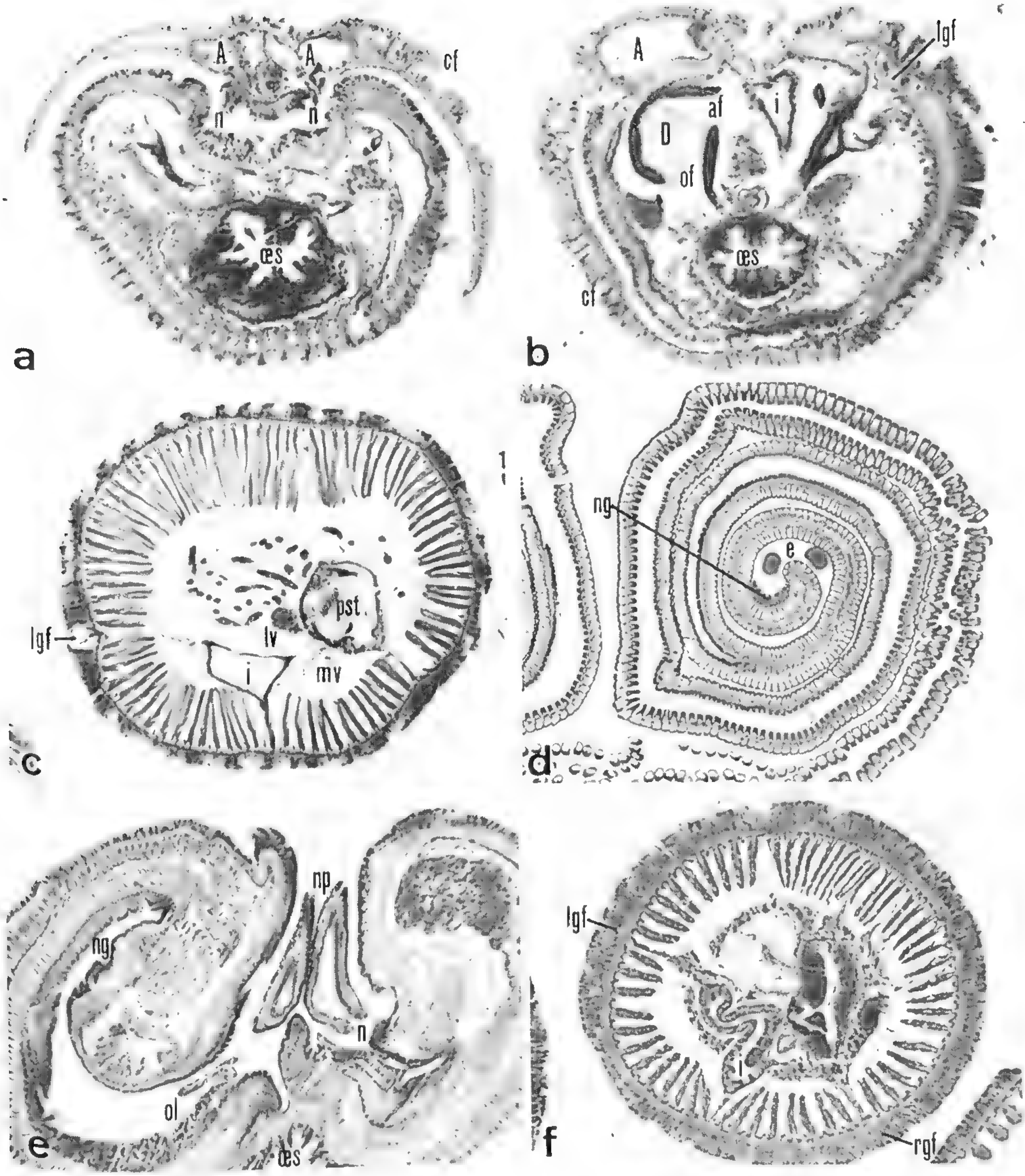

Fig. 9. *Phoronopsis harmeri.* (a) cross section of the collar fold, through the anal papilla and the nephridiopore; (b) cross section (below a) of the descending branch and two funnels of the right nephridium; (c) cross section of the muscular region. *Phoronis australis.* (d) cross section of the lophophore (left spiral only), showing the anterior part of the nidamental gland; (e) cross section of the nephridial papilla, with accessory sex glands in the lophophoral concavity; (f) cross section of the muscular region.

REMARKS: The material examined agrees well with the specific characteristics of *Phoronopsis harmeri.* The collar fold is very distinct, with the invagination much stronger than in *Phoronopsis albomaculata* (fig. 8b, d, g; fig. 9a, b).

The longitudinal muscle bundle formula was determined in six specimens:

$\frac{28 \mid 29}{18 \mid 13} = 88$; $\frac{30 \mid 29}{18 \mid 13} = 90$; $\frac{33 \mid 28}{18 \mid 20} = 99$; $\frac{31 \mid 30}{21 \mid 18} = 100$; $\frac{32 \mid 31}{21 \mid 16} = 100$; $\frac{42 \mid 33}{20 \mid 19} = 114$.

The Australian specimens, along with those recently described from the Cook Islands (Emig, 1973b) and from Marovo Lagoon (New Georgia Group, Solomon Islands: unpublished data), are smaller than *Phoronopsis harmeri* so far collected from the Pacific coast of North America. No gonads or other reproductive features were present in the local specimens, which may be juveniles.

At Careel Bay *P. harmeri* was found in *Zostera* beds in fine mud near low tide and at Wallis Lake this species occurs in muddy sand at 6-8 m depth.

DISTRIBUTION: Australia, Careel Bay, Wallis Lake (N.S.W.); Wider distribution — Pacific and Atlantic oceans (Emig, 1973b).

KEY TO SPECIES OF PHORONIDA

The results of the present study and the observations of Stancyk et al. (in press) and Emig (unpublished) concerning the nephridia and lophophore of *Phoronopsis albomaculata* and of *Phoronis ijimai* Oka have been incorporated in the key established by Emig (1971). Only the main taxonomic characters of the species are used, but all characters must be verified for the determination of a phoronid species.

1. Lophophore oval or horseshoe-shaped 2
— Lophophore spiral or helicoidal 8

2. Lophophore oval; nephridia with one funnel, descending branch absent; no lateral mesentery; burrowing habit .... *Phoronis ovalis*
— Lophophore horseshoe-shaped 3

3. Nephridia with one funnel, descending branch present; usually only left giant nerve fibre present 4
— Nephridia with two funnels, anal larger than oral; no invagination at base of lophophore; hermaphrodite 6

4. Invagination present at base of lophophore, although often not distinct on oral side; nephridiopore opening on collar fold below anus .... *Phoronopsis albomaculata*
— Invagination not present 5

5. All mesenteries present; nephridiopore below anus .... *Phoronis psammophila*
— Left lateral mesentery absent in muscular region; nephridiopore at level of anus; prebuccal and postbuccal tentacles of same length, lateral tentacles longer .... *Phoronis muelleri*

6. Descending branch of nephridia nearly as long as ascending branch; left giant nerve fibre only; circular muscles (three sphincters) and longitudinal muscles (six zones) unusual .... *Phoronis pallida*
— Descending branch of nephridia absent; nephridial papilla present; two giant nerve fibres; burrowing or encrusting habit 7

7. Ascending branch of nephridia in two horizontal chambers; longitudinal muscle bundles number 24-43 .... *Phoronis hippocrepia*
— Ascending branch of nephridia curved; longitudinal muscle bundle numbers 37-69 .... *Phoronis ijimai*

8. Lophophore spiral 9
— Lophophore helicoidal; nephridia with two funnels and descending branch; invagination present at base of lophophore, deep .... *Phoronopsis californica*

9. Invagination present at base of lophophore; right giant nerve fibre absent in muscular region; nephridia with descending branch 10
— Invagination not present; nephridia with two funnels, anal larger than oral; nephridia without descending branch; two giant nerve fibres 11

10. Nephridia with one funnel .... *Phoronopsis albomaculata*
— Nephridia with two funnels, anal smaller than oral; invagination very distinct .... *Phoronopsis harmeri*

11. Burrowing or encrusting species .... *Phoronis ijimai*
— Inhabitating cerianthid tube-wall; lophophore multispiral... *Phoronis australis*

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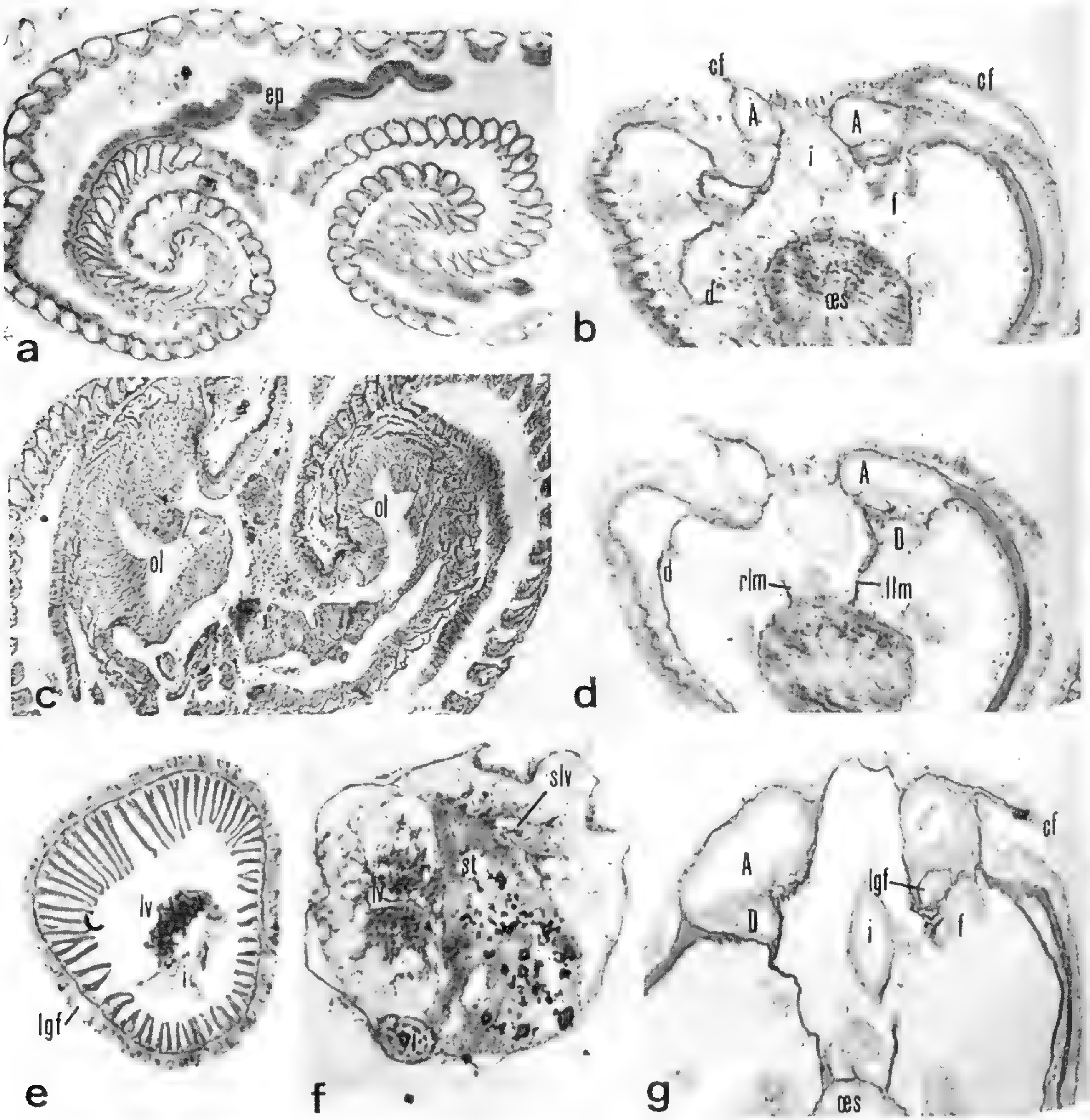

Fig. 8. *Phoronopsis albomaculata.* (a) cross section of the lophophore, without accessory sex glands; (b) cross section, slightly oblique, through the funnel; (c) cross section of the lophophore through the lophophoral organs; (d) cross section (below b) of the nephridia; (e) cross section of the muscular region; (f) cross section of the ampulla, showing testis in the two oral cavities; (g) cross section of the nephridia.

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APPENDIX

Recently, *P. australis, Phoronopsis harmeri, Phoronopsis albomaculata,* and a species new to Australian waters, *Phoronis muelleri* have been discovered near Peel Island and Middle Banks (Moreton Bay). Data on these specimens will be published later.

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REVIEW OF THE SHARPNOSE PUFFERFISHES (SUBFAMILY CANTHIGASTERINAE) OF THE INDO-PACIFIC

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SUMMARY

Twenty-two species of *Canthigaster* (Tetraodontidae; Canthigasterinae), including seven which are described as new, are recognized from the tropical Indo-Pacific: *C. amboinensis* (widespread Indo-Pacific), *C. bennetti* (widespread Indo-W. Pacific), *C. callisterna* (New South Wales; Lord Howe, Norfolk, and Kermadec islands; northern New Zealand), *C. compressa* (E. Indies; Melanesia; Philippine Islands), *C. coronata* (widespread Indo-W. Pacific), *C. epilampra* (W. Pacific), *C. inframacula* n. sp. (Hawaiian Islands), *C. investigatoris* (Andaman Islands), *C. jactator* (Hawaiian Islands), *C. janthinoptera* (widespread Indo-W. Pacific), *C. margaritata* (Red Sea), *C. marquesensis* n. sp. (Marquesas Islands), *C. natalensis* (Mauritius; South Africa), *C. ocellicincta* n. sp. (Melanesia; Great Barrier Reef), *C. punctatissima* (eastern Pacific), *C. pygmaea* n. sp. (Red Sea), *C. rapaensis* n. sp. (Rapa), *C. rivulata* (widespread Indo-W. Pacific), *C. smithae* n.sp. (Mauritius, and South Africa), *C. solandri* (widespread Indo-W. Pacific), *C. tyleri* n. sp. (Indian Ocean), and *C. valentini* (widespread Indo-W. Pacific). Notes are included on the ecology and distribution, and food habit data are presented for five species. Tables of meristic and morphometric characters, colour illustrations of 20 species, black-and-white photographs of three species, synonymies, and a diagnosis or description for each species are included.

INTRODUCTION

The tetraodontid subfamily Canthigasterinae is composed of the single genus, *Canthigaster*, which contains 23 species. These small (usually under 12 cm SL) fishes, commonly known as sharpnose puffers, are for the most part inhabitants of tropical reefs. The present paper deals with the taxonomy of the 22 species which inhabit the vast Indo-Pacific faunal region. Dr. James C. Tyler is investigating the systematics of the multi-patterned *C. rostratus* (Bloch) from the Atlantic Ocean. Seven species, including six which were recently collected by the authors at widely scattered localities in the Indian and Pacific Oceans, are herein described as new.

Traditionally the Canthigasteridae has been separated from the Tetraodontidae on the basis of its inconspicuous nostrils and characteristic body shape, which includes a laterally compressed form, an elongate and relatively pointed snout, and a carinate back. We supported this opinion until Dr. Tyler, who is studying the higher systematics of plectognaths, informed us of the discovery of a "missing link" of sorts between the canthigasterids and tetraodontids in the form of *Carinotetraodon somphongi* (Klausewitz),

a freshwater puffer from Thailand. This species is a tetraodontid, but bears some remarkable osteological similarities to *Canthigaster,* particularly with regards to the vertebral and caudal skeleton. Furthermore, it is the only tetraodontid, besides *Canthigaster,* which is able to erect a ridge of skin on the dorsal and ventral midline. Hence, a subfamilial ranking of the sharpnose puffers within the Tetraodontidae is suggested. This idea is also supported by Winterbottom (1974) in his myological study of the Tetraodontiformes.

The members of the group are probably better known for their general lack of characters, rather than for any distinguishing attribute. There is a monotonous sameness of external morphology from species to species, which according to Tyler (personal communication) holds true internally as well. Indeed, colour pattern differences constitute the most valuable "tool" for separating the species. Accordingly, we have illustrated all the species in colour except *C. investigatoris, C. punctatissima,* and *C. pygmaea.*

Contrary to the belief of some systematists, the colour pattern of Indo-Pacific species of *Canthigaster* is generally stable and is not influenced to any great extent by growth or geography. However, minor variations in the general pattern are not uncommon, and any two individuals of a given species rarely exhibit identical patterns of spots and lines. In all cases, except for *C. amboinensis* and *C. callisterna,* the juveniles (individuals less than approximately 35 mm SL) resemble the adults, although the number of spots or stripes may be reduced. Differences in fin-ray counts, interorbital width, and caudal peduncle length are useful to a lesser degree than colour.

Fraser-Brunner (1943) listed 15 species of *Canthigaster* in his generic synopsis of the Tetraodontoidea. These included *C. amboinensis, C. bennetti, C. callisternus, C. caudofasciatus, C. cinctus, C. compressus, C. janthinopterus, C. margaritatus, C. natalensis, C. papua, C. punctatissimus, C. rivulatus, C. rostratus, C. sancti-helenae,* and *C. valentini. C. sancti-henelae* is a probable synonym of *C. rostratus* from the Atlantic. The remaining Indo-Pacific species are recognized as valid in the present study except *C. caudofasciatus, C. cinctus,* and *C. papua* which are synonyms of *C. rivulata, C. coronata,* and *C. solandri* respectively.

The most recent and only noteworthy revision of *Canthigaster* is that of Le Danois (1961). However, this work cannot be seriously accepted. Only four species were recognized on the basis of the following broad colour pattern categories: (1) individuals with one or two longitudinal bands; (2) individuals with several transverse bands; (3) individuals with a large ocellus at the base of the dorsal fin; (4) individuals with spots, but without an ocellus. The valid entities within the genus are hopelessly confused under this scheme, which was also largely followed by Smith (1965).

Abe (1949) included six species in his account of the *Canthigaster* of Japan and adjacent regions. The most recent study of this group is a review of the species from Taiwan by Shen and Lim (1974). They recognize eight species, all of which are considered valid in the present study.

Canthigaster is omnivorous and feeds on a great variety of benthic organisms. Randall (1967) examined the stomach and gut contents of 26 specimens of *C. rostratus* from West Indian localities. He reported 18 different groups of food organisms, headed by marine spermatophytes (16.1% by volume) and sponges (15.0%). We present herein limited food habit data on five Indo-Pacific species: *amboinensis, bennetti, coronata, jactator,* and *solandri.*

Most of the species inhabit shallow water in the vicinity of coral reefs, sand flats, rubble areas, wreckage, and wharf pilings. However, at least two species, *C. epilampra* and *C. rivulata,* penetrate depths in excess of 35 fathoms, and two others, *C. inframacula* and *C. investigatoris* are known only from six specimens caught with a shrimp trawl and dredge in 55 to 86 fathoms.

Like other tetraodontids, they are capable of causing a violent form of fish poisoning if the flesh or internal organs are ingested by humans (see Halstead, 1967), or presumably by predatory fishes. *Canthigaster* also has a skin toxin which was reported by Eger and Starkus (1973). This toxin may serve as a repellant to predators. A dead adult of *C. solandri* was offered as food by J.E.R. to a 15-inch live snapper (*Lutjanus bohar*) in a tank at the Enewetak Marine Biological Laboratory. The snapper took the puffer into its mouth several times, but rejected it on each occasion. *Canthigaster* also possesses the ability to inflate its abdomen by swallowing water when frightened or injured. The above traits are probably adaptations which serve to compensate for the relatively poor swimming ability and resultant vulnerability to predation of these puffers.

C. amboinensis is the most widespread member of the genus, being distributed throughout the Indo-Pacific from East Africa to Central America. *C. coronata, C. rivulata,* and *C. solandri* are nearly as widespread with distributions which extend from East Africa to the Hawaiian Islands. *C. bennetti, C. janthinoptera,* and *C. valentini* have similar ranges, but are not found in the Hawaiian Islands. *C. epilampra* (western Pacific Ocean to the Hawaiian and Society Islands), *C. callisterna* (New South Wales, Lord Howe, Norfolk, and Kermadec Islands, and northern New Zealand), *C. compressa* (Palau Islands, Philippine Islands, East Indies, Amboina, and New Guinea), *C. natalensis* (Mauritius and southern Africa), *C. ocellicincta* (Fiji Islands, New Caledonia, Solomon Islands, and Great Barrier Reef, Philippines), *C. punctatissima* (eastern Pacific Ocean), *C. smithae* (Mauritius and South Africa), and *C. tyleri* (Maldive Islands, Grande Comore Islands, and Mauritius) are more restricted in their distributions. The remaining Indo-Pacific species, *C. inframacula* (Hawaiian Islands), *C. investigatoris* (Andaman Islands), *C. pygmaea* (Red Sea), and *C. rapaensis* (Rapa) have an apparent limited local distribution, although further collecting effort may expand their ranges.

MATERIALS AND METHODS

During the course of this study we have observed in the field, collected, and photographed in colour all the species except *C. punctatissimus* and the two deep-dwelling species, *C. investigatoris* and *C. inframaculus* (photographed only). The localities we visited include the Hawaiian Islands (G.R.A. and J.E.R.), Line Islands (J.E.R.), south-east Polynesia (J.E.R.), Marshall and Caroline Islands (G.R.A. and J.E.R.), Japan and Ryukyu Islands (J.E.R. and G.R.A), New Guinea (G.R.A. and J.E.R.), New Britain (G.R.A. and J.E.R.), Solomon Islands (G.R.A. and J.E.R.), New Hebrides (G.R.A.), New Caledonia (G.R.A. and J.E.R.), Fiji Islands (G.R.A. and J.E.R.), eastern Australia, including Lord Howe Island (G.R.A. and J.E.R.), Mauritius (J.E.R.), Tanzania (J.E.R.), Red Sea (G.R.A. and J.E.R.), Philippines (G.R.A. and J.E.R.), Ceylon (G.R.A. and J.E.R.), Maldives (J.E.R.) and Panama (G.R.A.).

All the available *Canthigaster* were examined at the following institutions: Academy of Natural Sciences, Philadelphia (ANSP); Australian Museum, Sydney (AMS); Bernice P. Bishop Museum, Honolulu (BPBM); British Museum (Natural History), London [BM(NH)]; California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Museum of Comparative Zoology, Harvard University; Hebrew University of Jerusalem (HUJ); Musee d'Histoire Naturelle, Paris (MNHN); Rijksmuseum van Naturlijke Histoire, Leiden (RMNH); Senckenberg Museum, Frankfurt (SMF); United States National Museum of Natural History, Washington, D.C. (USNM); Zoological Museum, Amsterdam; Zoological Museum, University of Copenhagen. In addition, loan material was provided by the J.L.B. Smith Institute of Ichthyology of Rhodes University, South Africa (RUSI), the Western Australian Museum, Perth (WAM), and the Zoological Survey of India, Calcutta (ZSI).

Preserved specimens of *Canthigaster* are particularly susceptible to distortion because of the distensible skin and lack of scales. Therefore the range of body proportions given in the species accounts below are considerably variable. The peculiar morphology of *Canthigaster* necessitates the definition of certain measurements as follows (from Tyler, 1967): head length is measured from the tip of the upper jaw (the tip of the exposed dental plates) to the upper edge of the gill opening; eye diameter is the greatest diameter of unpigmented skin over the eye; postorbital length is measured from the upper edge of the gill opening to the closest point of unpigmented skin over the eye; interorbital width is the least width of the bony interorbital as measured externally through the skin; depth of body is the slightly oblique measurement from the origin of the dorsal fin to origin of anal fin; body width is measured at the level of the pectoral fin base; caudal peduncle depth is the least depth; caudal peduncle length is measured obliquely from the base of the middle caudal rays (indicated by line of flexure) to the base of the posteriormost anal rays.

GENERIC ACCOUNT

Genus **Canthigaster**

Canthigaster Swainson, 1893: 194 (type species, *Tetrodon rostratus* Bloch by subsequent designation of Swain, 1882).

Psilonotus Swainson, 1839: 328 (type species, *Tetrodon rostratus* Bloch by subsequent designation of Swain, 1882).

Tropidichthys Bleeker, 1854: 500 (type species, *Tetraodon valentini* Bleeker by subsequent designation of Jordan, 1919).

Anosmius Peters, 1855: 274 (type species, *Tetrodon* (*Anosmius*) *taeniatus* Peters, by original designation = *Tetraodon valentini* Bleeker).

Rhynchotus Bibron, *in* Dumeril, 1855: 280 (type species, *Tetrodon gronovii* Cuvier [nomen nudum] by original designation).

Eumycterias Jenkins, 1901: 399 (type species, *Eumycterias bitaeniatus* Jenkins by original designation = *Tetraodon rivulatus* Schlegel).

Lucubrapiscus Whitley, 1931: 334 (type species, *Eumycterias bitaeniatus* Jenkins by original designation).

DIAGNOSIS: Dorsal rays 8 to 12 (most species with 9 or 10); anal rays 8 to 11 (usually 9); pectoral rays 14 to 18 (usually 16 or 17); vertebrae 17 (8 + 9).

Body depth 2.1 to 3.2, head length 2.1 to 2.9, tip of snout to dorsal origin 1.2 to 1.5, to anal origin 1.1 to 1.4, all in the standard length. Snout length 1.3 to 1.8, postorbital length of head 3.5 to 5.0, eye diameter 3.3 to 5.9, interorbital width 2.8 to 5.3, depth of caudal peduncle 1.7 to 2.9, length of caudal peduncle 1.4 to 2.6, middle caudal rays 1.1 to 1.6, all in the head length.

Body moderately compressed; snout long, conical; back with a movable ridge of skin on mid-dorsal line; ventral profile of body varying from nearly straight to convex; caudal peduncle strongly compressed, tapering in width towards caudal fin base; dental plates strong, convex, divided at symphysis; a single inconspicuous nostril on each side of snout; interorbital flattened; pectoral fin broad with short rays; dorsal and anal fins slightly rounded; caudal fin truncate or slightly convex; pelvic fins absent; head and body with scattered tiny prickles (more evident when inflated).

KEY TO THE INDO-PACIFIC SPECIES OF *CANTHIGASTER*

1. Dorsal rays usually 11 or 12 2
— Dorsal rays usually 8 to 10.. 5

2. Anal rays usually 11 (occasionally 10); caudal fin brownish with or without pale spots, but never with cross-bands 3
— Anal rays usually 9 or 10; caudal fin pale with prominent to faint cross-bands 4

3. Dorsal rays usually 12; interorbital without dark cross-bands; pale spots on caudal fin absent (Indo-Pacific, including eastern Pacific) ....*amboinensis* (p.499)
— Dorsal rays usually 11; interorbital with dark cross-bands; pale spots (faint in preservative) on basal half of caudal fin (Mauritius, Reunion, southern coast of East Africa .... *natalensis* (p.500)

4. Narrow dark brown lines present on interorbital and top of snout, becoming more numerous and irregular shaped with growth; subadults (below 50-60 mm SL) with white longitudinal band (about pupil width or slightly larger in diameter) extending from lower corner of mouth to base of caudal fin; upper and lower caudal fin margins dark; large dark blotch at base of dorsal fin absent; body depth 2.8 to 3.2 in SL; maximum size about 225 mm SL (New South Wales, Lord Howe, Norfolk, and Kermadec Islands, northern New Zealand).. *callisterna* (p.494)
— Narrow dark brown lines absent on interorbital and top of snout; subadults and adults without white longitudinal band on sides; caudal fin margins pale; large dark blotch present at base of dorsal fin; body depth 2.5 to 2.8 in SL; maximum size about 100 mm SL (this species also appears in Section 8 of key) (Rapa) .... *rapaensis* n. sp. (p.492)

5. Caudal fin with pattern of spots or vertical lines (sometimes wavy or broken) 6
— Caudal fin without spots or vertical lines 12

6. Middle of side without two prominent dark bars extending to belly region 7
— Middle of side with two prominent dark bars extending to belly region (this unusual colour form exhibiting spotted caudal fin known only from Mauritius) .... *valentini* (p.484)

7. Lower sides of body (below and slightly behind pectoral fin) with a large dark spot, equal in size or larger than eye; black stripe, about equal in width or slightly less than eye diameter, extending from behind eye to upper caudal peduncle (sometimes faded in large adults) (Hawaiian Islands, 68 to 86 fathoms).. *inframacula* n. sp. (p.493)
— Lower sides of body without large dark spot; black stripe behind eye absent 8

8. Predorsal region (including snout and interorbital) with pattern of either spots, stripes, wavy lines, transverse bands or combination of these; caudal fin with distinct or faint spots or with faint rows of vertical, wavy lines; dorsal rays usually 8 or 9 (occasionally 10) 9
— Predorsal region uniform brownish without pattern of spots, stripes, wavy lines, or transverse bars; caudal fin pale with 6 to 8 prominent, broken cross-bands; dorsal rays 10 or 11 (Rapa) .... *rapaensis* n. sp. (p.492)

9. Caudal fin with round spots (may be faint, especially in preservative); body with uniform spotting, except on ventral surface.. 10
— Caudal fin with series of faint, narrow undulating lines (sometimes broken); body covered with maze of blue, brown, or reddish undulating lines (Palau Islands, Philippine Islands, E. Indies; New Guinea, Solomon Islands, New Hebrides, Taiwan.) .... *compressa* (p.483)

10. Dorsal rays usually 9 or 10; anal rays usually 9; horizontal rows of spots on caudal peduncle usually greater than 10 (at least in specimens over 50 mm SL) 11
— Dorsal and anal rays usually 8; horizontal rows of spots on caudal peduncle less than 10 (Red Sea) . . . . . *margaritata* (p.481)

11. Caudal fin uniformly covered with distinct round spots; head usually with about 8 to 10 dark lines radiating from eye; cross-bands usually present on interorbital and upper portion of snout (Indo-W. Pacific, including Hawaiian Islands) . . . . . *solandri* (p.479)
— Caudal fin with faint round spots (at least in preservative), particularly apparent on basal portion; head usually lacking lines which radiate from eye; interorbital and upper portion of snout covered with small pale spots (tropical eastern Pacific) . . . . . *punctatissima* (p.494)

12. Upper portion of head and body with 2 to 4 dark bars, wider than pale interspaces 13
— Upper portion of head and body without dark bars 15

13. Upper portion of head and body with 4 dark bars, those of head and upper caudal peduncle forming abbreviated saddles; no ocellus at base of dorsal fin 14
— Upper portion of sides with 2 dark bars; saddles on head and caudal peduncle absent; ocellus present at base of dorsal fin (Solomon Islands, Fiji Islands, New Caledonia, Great Barrier Reef) . . . . . *ocellicincta* n. sp. (p.483)

14. First 2 bars of body with narrow extensions continuing below middle of sides; bar on head largely posterior to interorbital space; dorsal rays usually 9 (see couplet 6 also) (Indo-W. Pacific) . . . . . *valentini* (p.482)
— First 2 bars of body terminate at about middle of sides; bar on head largely confined to interorbital space; dorsal rays usually 10 (Indo-W. Pacific, including Red Sea and Hawaiian Islands) . . . . . *coronata* (p.484)

15. Side of body with 1 or 2 dark longitudinal bands (sometimes fragmented) extending along side of body 16
— Side of body without longitudinal bands 18

16. Upper back more or less uniform brown; anal rays 9; sides with 1 or 2 longitudinal bands 17
— Upper back with brown vermiculated pattern; anal rays usually 10; side of body with 2 longitudinal and parallel bands, joining to form arc in front of gill opening (Indo-W. Pacific, including Hawaiian Islands) . . . . . *rivulata* (p.490)

17. Side of body with a single dark longitudinal band extending from pectoral fin to caudal peduncle region, about equal to eye diameter in width (Marquesas Islands) . . . . . *marquesensis* n. sp. (p.485)
— Side of body with 2 dark bands, each less than pupil width, placed approximately at level of upper and lowermost ends of pectoral base, extending from anterior part of head to caudal base; bands sometimes fragmented or missing entirely (see 24 below) (south-western Indian Ocean, including Mauritius and South Africa) . . . . . *smithi* n. sp. (p.487)

18. Body with uniform pattern of rounded spots, either whitish, bluish, brown or grey in colour, the largest at least 1/3 to ½ pupil size; dorsal portion of body usually same colour as sides; dorsal and anal rays usually 9 19

— Body without uniform pattern of rounded spots; dorsal portion of body usually darker than adjacent region on sides; dorsal rays 9 or 10; anal rays usually 9. 22

19. Pectoral rays usually 17 (occasionally 16); spots relatively close-set, usually more than 15 on side of caudal peduncle; maximum size at least 60 mm SL 20
— Pectoral rays usually 15; spots relatively scattered, usually less than 10 on side of caudal peduncle; maximum size only 40-45 mm SL (Red Sea). . . . . *pygmaea* n. sp. (p.496)

20. Spots on head and body mostly pale; ground colour brown 21
— Spots on head and body mostly pale; ground colour yellowish-tan (Indonesia and Indian Ocean, including Maldive Islands, Comoro Islands and Mauritius) . . . . *tyleri* n. sp. (p.495)

21. Usually more than 12 pale spots in an approximate vertical row from dorsal fin origin to anal fin origin; lines radiating from eye frequently present; dark spot or ocellus (sometimes only partially developed) frequently present at base of dorsal fin (Indo-W. Pacific) . . . . *janthinoptera* (p.493)
— Usually less than 10 pale spots in an approximate vertical row from dorsal origin to anal fin origin; lines radiating from eye absent; dark spot or ocellus at base of dorsal fin absent (Hawaiian Islands) . . . . *jactator* (p.494)

22. Pectoral rays 15 or 16 23
— Pectoral rays usually 17 (rarely 16) 24

23. Pectoral rays 15 or 16; dorsal rays 9 or 10; body depth 2.6 to 3.2 in SL (usually greater than 2.8); less than 30 small brown dots on side of caudal peduncle; dark spot or ocellus present at dorsal fin base (Indo-W. Pacific). . . *bennetti* (p.486)
— Pectoral rays 15; dorsal rays 9 or 10; body depth about 2.8; spots on side of caudal peduncle and ocellus at dorsal fin base absent (Andaman Islands, 55 fathoms) . . . . *investigatoris* (p.499)

24. Prominent dark brown blotch about 2 to 3 times size of eye, usually present at base of dorsal fin; several horizontal dark bands at caudal base slanting towards middle of fin; upper and lower margins of caudal fin pale (W. Pacific, including Hawaiian Islands) . . . . *epilampra* (p.489)
— Prominent dark brown blotch at base of dorsal fin absent; horizontal dark bands at caudal base absent; upper and lower margins of caudal fin dark (south-western Indian Ocean, including Mauritius and South Africa) . . . . *smithae* n. sp. (p.487)

SPECIES ACCOUNTS

Canthigaster solandri (Richardson)

Fig. 1A, B, C.

Tetraodon solandri Richardson, 1844: 125, pl. 57, figs. 4-6 (type locality, Polynesia).

Tetraodon papua Bleeker, 1848: 638 (type locality, East Indian Archipelago).

Tetrodon petersii Bianconi, 1855: 147, pl. 2, fig. 2 (type locality, Mozambique).

Canthigaster australis Stead, 1907: 7, pl. II (type locality, Suwarow Island).

Canthigaster glaucospilotus Fowler, 1944: 185, figs. 33 and 34 (type locality, New Hebrides).

Canthigaster saipanensis Fowler, 1945: 73, fig. 18 (type locality, Saipan, Mariana Islands).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 to 10 (usually 9); pectoral rays 15 to 18 (usually 17).

Depth 2.1 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.2 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.3 to 1.5, postorbital length of head 3.6 to 4.5, eye 4.1 to 5.3, interorbital 2.9 to 4.6, depth of caudal peduncle 1.7 to 2.2, length of caudal peduncle 1.7 to 2.4, of middle caudal rays 1.1 to 1.5, all in head length.

Colour in alcohol reddish brown with numerous blue-white to greyish spots; darkish blotch or ocellus usually present at base of dorsal fin; ventral surface of body tan to pale brown without spots; head usually with about 8 to 10 dark lines radiating from eye, the continuations of which usually form cross-bands on the interorbital and upper portion of snout; lower portion of side of head with bluish to grey spots about equal to or smaller than pupil size in diameter; area immediately below eye sometimes with fine brown speckling which grades into larger spots below, tip of snout whitish; dorsal, anal, and pectoral rays with fine dark borders, remainder of ray and fin membranes transparent or yellowish; caudal fin red-brown to tan with bluish or reddish spots, the outer rows of which may be fused into irregular bars.

REMARKS: The differences between C. *solandri* and the closely related C. *margaritata* from the Red Sea are discussed under the remarks section for the latter species.

There is considerable variation in the size and number of spots in this widespread species. Juvenile specimens from Oceania (Fig. 1A) and both juveniles and adults from the western Indian Ocean generally have larger and fewer spots. Adults from Oceania (Fig. 1B) frequently exhibit spots which are relatively small and very numerous. The pattern of lines which radiate out from the eye is also variable; a few specimens lack these lines entirely. Occasionally the spots on the upper part of the back coalesce to form narrow stripes. These are often well developed in adult specimens ("papua" variety) from the Palau and Philippine Islands, Indonesia, and western Melanesia. In addition, the ground colour of the "papua" form is frequently darker than individuals from other localities. This variety is shown in Fig. 1C. A specimen, 84 mm SL, collected by J.E.R. at Mauritius has the upper back covered with narrow pale stripes, similar to those found in the "papua" form. In addition, the three outermost rows of spots on the posterior margin of the caudal fin coalesce to form wavy lines.

The type of *solandri* [BM(NH) 1858.6.61], a specimen 42.1 mm SL from Polynesia was examined by J.E.R.

We have examined 176 specimens, 9.5 to 84.6 mm SL from various Indo-W. Pacific localities including the Hawaiian Islands, Society Islands, Tuamotu Archipelago, Samoa Islands, Fiji Islands, Mariana Islands, Caroline Islands, New Guinea, Philippine Islands, East Indies, India, Ceylon, Seychelles Islands, Kenya, Mozambique, and South Africa. All of these localities have been reported previously by De Beaufort and Briggs (1962) as C. *margaritatus*, along with others such as Thornton Island, Phoenix Islands, Rotuma, Ellice Islands, New Britain, Palau Islands, China, Muscat, Aden, Madagascar, and Zanzibar. Smith and Smith (1963) listed it from Seychelles Islands. Shen and Lim (1974) reported it from Taiwan. In addition, specimens have been examined from the Line Islands, Austral Islands, Cook Islands, Tonga Islands, Marshall Islands, Gilbert Islands, Solomon Islands, Malacca Strait, and Mauritius which constitute new records for these areas. C. *solandri* is represented from Hawaii by only two specimens, one collected by J. W. Thompson sometime during the first quarter of this century, and the other by the junior author and his wife in 1956. At other localities visited by the authors *solandri* was generally the most common species of the genus on shallow rocky bottom, coral reefs, wharf pilings, etc. Our specimens have been collected in the depth range of one to 16 metres.

An analysis of the stomach and gut contents of eight specimens (60-77 mm SL) from five stations at Enewetak revealed 58.4% algae (mixed with detritus), 16.8% tunicates (mostly didemnids), 11.1% coral, 3.6% foraminifera, 1.8% bryozoans, 1.6% crabs, 1.4% ophuroids, 1.3% gastropods, 1.2% sponge, 0.8% polychaetes, and 2.0% unidentified.

Canthigaster margaritata (Rüppell)
Fig. 2A

Tetraodon margaritatus Rüppell, 1828: 66 (type locality, Red Sea).

DIAGNOSIS: Dorsal rays 8 or 9 (usually 8); anal rays 8 or 9 (usually 8); pectoral rays 16 to 18 (usually 17).

Depth 2.5 to 3.0, head length 2.2 to 2.5, tip of snout to dorsal origin 1.3, to anal origin 1.2 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.5 to 5.0, eye 4.0 to 5.9, interorbital 3.9 to 4.8, depth of caudal peduncle 2.2 to 2.9, length of caudal peduncle 1.9 to 2.6, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol reddish-brown with numerous whitish to greyish spots about size of pupil or smaller; ventral surface tan or light brown without spots; ocellus at base of dorsal fin weakly developed; head usually with about 6 to 10 dark lines radiating from eye; interorbital and tip of snout usually with combination of thin dark cross-bands and small brownish dots (difficult to detect in some preserved material); tip of snout tan; dorsal, anal, and pectoral rays light brown or dusky with fine dark borders; membranes transparent or yellowish; caudal fin reddish-brown with pale spots, the outer rows of which may be partially or completely fused into bars.

REMARKS: This species is closely related to *C. solandri* of the Indo-Pacific. However, there are good differences for separating the two. *C. margaritata* is the only member of the genus usually having 8 dorsal and anal rays. It is further separable from *solandri* by being less deep-bodied (Fig. 8) and by having generally fewer and larger spots on the body. In addition, the lines which radiate from the eye and the cross-bands on the interorbital are not as well developed as in *solandri*, sometimes scarcely apparent, at least in preserved specimens.

According to Dr. W. Klausewitz (personal communication) of SMF, the type specimen has been lost since at least 1852 when Rüppell published his "verzeichnis".

We have examined 35 specimens, 39.2 to 89.0 mm SL, from the Red Sea, the only known locality.

Canthigaster compressa (Marion de Procé)
Fig. 2B

Tetrodon compressus Marion de Procé, 1822: 130 (type locality, Manila, Philippine Islands).

Tetraodon striolatus Quoy and Gaimard, 1824: 203 (type locality, Timor).

Tetrodon insignitus Richardson, 1848: 20, pl. 9, fig. 1-2 (type locality, Sea of China).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 or 9 (usually 9); pectoral rays 15 to 18.

Depth 2.4 to 3.1, head length 2.4 to 2.6, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.7 to 5.0, eye 4.4 to 5.5, interorbital 2.9 to 3.8, depth of caudal peduncle 2.0 to 2.4, length of caudal peduncle 1.7 to 2.3, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally red-brown dorsally, pale ventrally; sides covered with maze of irregular reddish lines; cheek with dense network of small spots; dorsal portion of snout with series of dark cross-bands, breaking up into irregular pattern on interorbital or immediately behind; eye with radiating dark lines continuous with cross-bars of snout; dorsal portion of body from orbits to upper caudal base with vermiculating dark stripes; prominent ocellus at base of dorsal fin; scattered brown spots on abdomen; midline of abdomen with brown stripe extending to anus; dorsal, anal, and pectoral fins pale; caudal fin covered with combination of spots and vertical wavy lines.

REMARKS: This species was observed by the authors at Madang and Samarai, New Guinea, and Guadalcanal, Solomon Islands. In these areas the fish were found chiefly around wharf pilings in silty harbours.

C. compressa is closely related to *C. solandri.* We separate the two principally by colour. Individuals of *solandri* were also present on the wharf pilings at Madang and Samarai, thus affording an opportunity for direct underwater comparison. The two species were usually seen in conspecific pairs or trios. Occasional agonistic chasing was observed when the two species encountered one another. On the other hand, conspecific agonistic behaviour was minimal.

Apparently there are no type specimens in existence. Marion de Procé (1822) stated that most of the specimens were destroyed before being sent to Europe during a revolt which took place in Manila. M. L. Bauchot (personal communication) stated there are no types at MNHN.

We have examined 107 specimens, 11.8 to 86.9 mm SL, from Palau Islands, Solomon Islands, New Guinea, Ambon, Borneo, and the Philippine Islands. De Beaufort and Briggs (1962) reported these areas, except Palau and Borneo, along with several Indonesian localities and New Hebrides. The records from Fiji and Hawaiian Islands listed by these authors are doubtful. In addition, it was recorded from Taiwan by Shen and Lim (1974).

Canthigaster valentini (Bleeker)
Fig. 3A

Tetraodon gronovii Cuvier, 1829: 369 (nomen nudum).

Tetraodon Valentini Bleeker, 1953: 130 (type locality, Amboina).

Tetrodon (Anosmius) taeniatus Peters, 1855: 275 (type locality, Mozambique).

Rhynchotus laterofasciatus Bibron, *in* Dumeril, 1855: 282 (nomen nudum).

DIAGNOSIS: Dorsal rays 9; anal rays 9; pectoral rays 16 or 17 (usually 16).

Depth 2.5 to 2.9, head length 2.2 to 2.5, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 4.2 to 5.0, eye 3.5 to 5.0, interorbital 2.8 to 4.2, depth of caudal peduncle 2.2 to 2.8, length of caudal peduncle 1.7 to 2.5, of middle caudal rays 1.4 to 1.5, all in head length.

Colour in alcohol pale tan or yellowish with four broad brownish or blackish bars (anteriormost bar connects rear portion of each eye, the two middle bars extend from mid-dorsal region to abdomen, posteriormost bar covers dorsal portion of caudal peduncle); pale portion of head and sides covered with numerous brown dots; usually 5 to 7 dark lines radiating from eye; fins pale except basal portion of upper and lower caudal fin margins, which are sometimes brownish. Small specimens tend to have fewer brown dots on the side of the head and body. A specimen, 82 mm SL, collected by J.E.R. at Mauritius has spots on the caudal fin.

REMARKS: Tyler (1967) clarified the taxonomy of the transversely barred species of *Canthigaster (coronata* and *valentini).* Previous to his work the name *cinctus* was sometimes applied to this species (Tanaka, 1912; McCulloch, 1912; Clark and Gohar, 1953; Randall and Randall, 1960; Marshall, 1964), as well as to *C. coronata,* the other barred species. The primary differences between *valentini* and *coronata* are colour pattern (refer to key) and dorsal and pectoral ray counts (Table 1). However, Tyler (1967) provides evidence for an increase in the number of fin rays with increased growth. He feels the modal difference in the counts may not be significant due to the larger average size (hence, higher counts) of *C. coronatus* specimens. Tyler also found a significant difference in the interorbital width. The average interorbital width of 69 specimens of *C. valentini* he examined was 11.1% of the standard length, while that of eight specimens of *C. coronata* was 9.3% of the standard length. We examined 16 specimens of *C. coronata* which had an average interorbital width of 9.0% of the standard length.

The type of *valentini* appears to be lost. Tyler (1967) searched for it without success in several European museums including RMNH, where many of the Bleeker types are deposited. He concluded that the type specimen is either missing or its total length was not accurately reported by Bleeker. Three specimens (approximately 27-65 mm SL) catalogued under MNHN 219 and 2306 are registered as types, but the validity of this designation is doubtful.

We have examined 59 specimens, 13.2 to 67.8 mm SL from the Tuamotu Archipelago, Mariana Islands, Palau Islands, Ryukyu Islands, New Britain, Solomon Islands, Fiji Islands, Queensland, New South Wales, Lord Howe Island, and Muscat, Arabia. The following localities were previously listed by Tyler (1967): Tuamotu Islands, Caroline Islands, Mariana Islands, New Hebrides, Queensland, Bonin Islands, Japan, South Vietnam, Philippine Islands, Indonesia, Seychelles Islands, and Amirantes, Comoro Islands, Mauritius, Madagascar, Zanzibar, Mozambique, and South Africa. The largest specimen he examined measured 80.3 mm SL, from Mauritius. Shen and Lim (1974) recorded the species from Taiwan and R. H. Kuiter (personal communication) has taken it at Sydney, Australia.

C. valentini is one of the more common members of the genus. It occurs on coral reefs to depths of at least 20 metres.

The remarkable case of mimicry of *C. valentini* by the filefish *Paraluteres prionurus* has been described by several authors (Clark, 1951; Clark and Gohar, 1953; Randall and Randall, 1960; Tyler, 1966). The colour pattern and general body shape of *P. prionurus* is virtually identical to *C. valentini.* It is difficult to differentiate the two in the field, but they are readily separated in the laboratory. *P. prionurus* has a well developed dorsal spine, 26-27 dorsal fin rays, 23-24 anal fin rays, 11 pectoral rays and 12 caudal fin rays. Apparently the less abundant and relatively defenseless *Paraluteres* mimics *C. valentini* because of the latter's toxicity, thus enabling it to enjoy some freedom from predation.

Canthigaster ocellicincta n. sp.

Fig. 3B; Table 2

HOLOTYPE: BPBM 15933, 50.1 mm SL, collected with rotenone off Tanavulu Point near entrance to Sandfly Passage, Florida Island, Solomon Islands, in 20-30 metres by G. Allen and J. Randall on 30 July 1973.

PARATYPES: AMS I.17500-001, 42.3 mm SL, same data as holotype; BPBM 18378, 2 specimens, 37.0 and 50.0 mm SL, collected with spear off east side of Mactan Island, Cebu, Philippine Islands in 43-53 metres by J. Randall on 27 June 1975; MNHN 1975-2, 35.7 mm SL, collected at New Caledonia in 1973, remaining data unavailable; USNM 211299, 33.4 mm SL,

same data as holotype; WAM P25283-004, 28.0 mm SL, collected off entrance to Suva Harbour, Viti Levu, Fiji Islands in 30 metres by B. Carlson, B. Goldman, and B. Russell on 10 July 1974.

DESCRIPTION: See Table 2 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9; anal rays 9; pectoral rays 16.

Depth 2.6 (2.5 to 3.0), greatest body width 4.2 (4.0 to 4.5), head length 2.3 (2.1 to 2.4), distance from tip of snout to dorsal origin 1.3, to anal origin 1.3, all in standard length. Snout length 1.6 (1.5 to 1.8), eye diameter 4.1 (3.2 to 3.7), postorbital length of head 5.4 (4.4 to 5.9), least width of interorbital 3.4 (3.4 to 4.6), least depth of caudal peduncle 2.1 (2.3 to 3.1), length of caudal peduncle 2.2 (2.0 to 2.7), of dorsal fin base 5.1 (4.7 to 6.7), of anal fin base 5.4 (5.3 to 8.0), of longest dorsal ray 2.7 (2.5 to 2.8), of longest anal ray 3.2 (3.0 to 3.4), of longest pectoral ray 3.2 (2.7 to 3.3), of middle caudal rays 1.2 (1.2 to 1.3), all in head length.

Colour of holotype in alcohol: Ground colour of head and body tan; side of head with series of 8-9 faint stripes (blue in life), those on snout forming narrow lines confluent dorsally with those of opposite side; six narrow brown lines across interorbital; two brownish bars with intermediate whitish area between posterior portion of head and level of dorsal fin origin; narrow whitish margin on front of anteriormost bar; two pale brown stripes extending obliquely downwards from base of uppermost caudal rays to level of posteriormost dorsal ray; posterior portion of body and caudal peduncle with 5-6 horizontal rows of faint (bluish in life) spots; dark brown ocellus at base of dorsal fin; diffuse brown mid-ventral stripe from anus to level of pectoral base; fins translucent with rays thinly outlined with dark pigment.

The paratypes are similar in colouration except the two bars on the middle of the sides are darker.

REMARKS: *C. ocellicincta* is most closely related to *C. valentini*, differing primarily with regards to colour pattern. The former species lacks dark saddles on the postorbital and upper caudal peduncle which are characteristic for *C. valentini*. In addition, the configuration of the dark bars and presence of an ocellus at the base of the dorsal fin of *ocellicincta* are particularly diagnostic. See Figs. 3A and B for further colour comparisons.

Three of the type specimens were collected from a narrow ravine on the steep seaward slope off the northern end of Florida Island, Solomon Islands. The species also occurs at New Caledonia, Fiji Islands, and One Tree Island, Capricorn Group, Great Barrier Reef. Mr. Rudie Kuiter provided the authors with a colour transparency of a live aquarium specimen, approximately 20 mm SL, collected in 25 metres at One Tree Island.

Named *ocellicincta* in reference to the characteristic colour pattern.

Canthigaster coronata (Vaillant and Sauvage)
Fig. 3C

Tetraodon (*Anosmius*) *coronatus* Vaillant and Sauvage, 1875: 286 (type locality, Hawaiian Islands).

Canthigaster cinctus Jordan and Evermann, 1905: 433, pl. 73 (type locality, Hawaiian Islands).

Canthigaster axiologus Whitley, 1931: 333 (substitute name for *cinctus* McCulloch, 1922).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 10); anal rays 9 or 10 (usually 9); pectoral rays 16 or 17 (usually 17).

Depth 2.6 to 2.9; head length 2.2 to 2.6, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.8, postorbital length of head 3.8 to 4.9, eye 4.1 to 4.9, interorbital 3.9 to 5.3, depth of caudal peduncle 2.2 to 2.9, length of caudal peduncle 1.8 to 2.1, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol pale tan or yellowish with four blackish or dark brown bars (anteriormost bar connects eyes and covers most of interorbital region; The two middle bars extend from mid-dorsal region to middle of sides, posteriormost bar covers dorsal portion of caudal peduncle); pale portion of head and sides with numerous brown dots (may be whitish on some specimens); usually 5 to 10 dark lines radiating from eye; fins pale except basal portion of upper and lower caudal fin margins, which may be brownish.

REMARKS: Tyler (1967) showed that the name *coronata* proposed by Vaillant and Sauvage (1875) precedes the name *cinctus*, which has been used by many authors (Jordan and Evermann, 1905; Jordan and Seale, 1906; McCulloch, 1922; McCulloch and Whitely, 1925; Gosline and Brock, 1960; Marshall, 1964; McKay, 1970) for this species. The differences between *C. coronata* and the closely related *C. valentini* are discussed under the remarks section for the latter species.

The type of *coronata* (MNHN 9006), a specimen 103.2 mm SL, from Hawaii was examined by J.E.R.

The distribution of *C. coronata* is relatively poorly known in spite of its widespread occurrance. Tyler (1967) examined 14 specimens, 53.8 to 103.4 mm SL, from the Hawaiian Islands, Philippine Islands, Seychelles Islands, Red Sea, and Somali. McCulloch (1922) reported it from Queensland as *C. cinctus*. We have examined 25 specimens, 39.5 to 103.2 mm SL from the Hawaiian Islands, Ifaluk Atoll (Caroline Islands), New South Wales, Western Australia, Japan, Red Sea, Mauritius, and Mozambique. In addition, we observed a pair in 27 metres depth at One Tree Island, Capricorn Group, Great Barrier Reef. R. Kuiter (personal communication) has collected this species as far south as Sydney, Australia. It was also reported from Taiwan by Shen and Lim (1974).

At Hawaiian Islands, *C. coronata* is most commonly seen below depths of about 15 metres, although occasional individuals are sighted in water as shallow as 6 metres. Tyler (1967) examined specimens that were dredged from 258-396 feet in the Hawaiian Islands.

An analysis of the stomach and gut contents of 12 specimens (64-97 mm SL) from six stations off Oahu, Hawaiian Islands revealed 13.3% algae (mixed with detritus), 11.9% gastropods, 10.0% crabs, 9.7% pelycypods, 8.9% polychaetes, 7.7% sponge, 7.0% sipunculids, 6.1% ophiuroids, 5.9% byrozoans, 4.7% tunicates (mostly didemnids), 3.3% echinoids, 2.4% foraminifera, 1.7% amphipods, 0.7% shrimp, 0.1% isopods, and 6.6 unidentified.

Canthigaster marquesensis n. sp.
Fig. 4A; Table 3

HOLOTYPE: BPBM 11129, 69.6 mm SL, collected with multiprong spear on north-west side of Sentinelle de l'Est, Nuku Hiva, Marquesas Islands in 15-18 metres by J. Randall on 14 May 1971.

PARATYPES: AMS I. 11678-001, 62.8 mm SL, collected with multiprong spear at bay on north side of Ua Pou, Marquesas Islands in 18 metres by J. Randall on 28 April 1971; BM(NH) 1972.10.241, 64.7 mm SL, same data as holotype; BPBM 11109, 89.0 mm SL, collected with rotenone off point at north side of Hanauu Bay, Fatu Hiva, Marquesas Islands in 24 metres by J. Randall, D. Cannoy, and R. McNair on 21 April 1971; BPBM 11113, 67.0 mm SL, same data as preceding paratype except collected with multiprong spear in 28 metres by J. Randall on 20 April 1971; BPBM 11124, 60.0 mm SL, collected with rotenone on west side of Sentinelle de

l'Ouest, Nuku Hiva, Marquesas Islands in 31 metres by J. Randall, D. Cannoy, and D. Bryant on 16 May 1971; BPBM 11126, 2 specimens, 52.9 and 71.9 mm SL, same data as holotype except collected in 24 metres on 1 May 1971; BPBM 11146, 2 specimens, 33.3 and 66.0 mm SL, collected with rotenone off point at south end of Vaitahu Bay, Tahuata, Marquesas Islands in 35-42 metres by J. Randall, D. Cannoy, and J. Haywood on 23 April 1971; CAS 15453, 67.0 mm SL, same data as holotype; USNM 208267, 53.4 mm SL, same data as holotype.

DESCRIPTION: See Table 3 for measurements of selected types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (two paratypes with 9); anal rays 9; pectoral rays 17 (one paratype with 18).

Depth 2.8 (2.7 to 2.9), head length 2.7 (2.6 to 2.8), tip of snout to dorsal origin 1.4 (1.3 to 1.4), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout 1.5 (1.4 to 1.7), postorbital length of head 3.8 (3.5 to 4.4), eye 4.3 (3.7 to 5.5), interorbital 4.1 (3.8 to 4.4), depth of caudal peduncle 2.4 (2.3 to 2.6), length of caudal peduncle 1.6 (1.5 to 1.8), of middle caudal rays 1.4 (1.2 to 1.5), all in head length.

Colour of holotype in alcohol: head and body generally brownish dorsally; tan ventrally; prominent dark brown longitudinal band, about equal to eye diameter in width, extending from pectoral fin axil to caudal peduncle; dorsal portion of body with network of dark irregular blotches; dark spot, about size of eye, at base of dorsal fin; dark blotch about size of pupil anterior to and slightly below pectoral fin base; area surrounding mouth whitish with brownish zebra-like stripes; perimeter of eye narrowly whitish, intersected by brownish spokes, those of the opposite side not meeting over snout or interorbital; series of approximately 15 to 20 narrow, parallel pale lines on postero-ventral region of body (lower caudal peduncle for the most part), extending diagonally in antero-ventral to postero-dorsal direction, intersecting prominent longitudinal band; five to six brownish horizontal bands at caudal base, slanting towards middle of fin; dorsal, anal, pectoral, and caudal fins pale.

REMARKS: *C. marquesensis* is closely related to *C. epilampra*. The two species have similar fin ray counts, but can be distinguished on the basis of colour pattern (Fig. 3A and C), body depth, and caudal peduncle length. *C. marquesensis* tends to be less deep-bodied than *C. epilampra* (Fig. 10), and usually has a longer caudal peduncle (Fig. 11).

Named *marquesensis* in reference to the type locality. It has not been collected outside of the Marquesas Islands.

Canthigaster bennetti (Bleeker)

Fig. 2C; Table 4

Tetrodon ocellatus (non Bloch) Bennett, 1830: 21.

Tropidichthys Bennetti Bleeker, 1854: 504 (type locality, Amboina).

Canthigaster constellatus Kendall and Goldsborough, 1911: 336, pl. 7, fig. 2 (type locality, Paumotu Islands).

Tropidichthys oxylophius Smith, 1931: 159, pl. 16 (type locality, Port Alfred, South Africa).

DIAGNOSIS: Dorsal rays 9 to 11 (usually 9-10); anal rays 8 to 10 (usually 9); pectoral rays 14 to 16 (usually 15). See Table 4 for additional information.

Depth 2.6 to 3.2, head length 2.6 to 2.8, tip of snout to dorsal origin 1.4, to anal origin 1.3 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.6 to 5.0, eye 4.0 to

5.5, interorbital 4.0 to 4.8, depth of caudal peduncle 2.1 to 2.7, length of caudal peduncle 1.4 to 1.7, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally brownish dorsally, pale tan ventrally; head, back, and sides with numerous small brown and white spots; indistinct dark blotch or ocellus at base of dorsal fin, about size of eye or slightly larger; upper part of caudal peduncle with one to several indistinct dark stripes (sometimes broken); eye with radiating brown lines, those from opposite side not meeting over snout or interorbital; several broken vertical brown lines on cheek just posterior to mouth; faint brown stripe on ventral mid-line from chin to anus; dorsal, anal, and pectoral fins pale with dark-edged fin rays; caudal fin mostly pale, sometimes brownish basally.

REMARKS: The differences between *C. bennetti* and its closest relative *C. epilampra* are discussed under the remarks section for the latter species. Whereas most specimens of other members of the genus have a strong modal count of a single number of dorsal rays, the modal dorsal ray count for *bennetti* includes two rays (see Table 4).

Bleeker (1854) based his description on nine examples, 45-81 mm TL from Amboina. Dr. M. Boeseman (personal communication) reported that RMNH 7360 contains 60 specimens which were purchased at the auction of Bleeker's collections in 1879. He said that 31 of these specimens are too small, but any of the remaining 29 may be syntypes. It is not possible to ascertain which 9 of the 29 are the syntypes or even to be certain that any are types.

Tropidichthys oxylophius described by Smith (1931) is most likely a synonym of *C. bennetti*. The description is based on a juvenile specimen, 32 mm TL, from the mouth of the Kareiga River, near Port Alfred, South Africa. Smith's colour description agrees closely with a specimen of *C. bennetti*, 23.5 mm SL, from Mozambique. We have also examined a specimen, 29.0 mm SL, from off the Xora River, which is a short distance south-west of Port Alfred. The only obvious discrepancy between *T. oxylophius* and *C. bennetti* is Smith's record of only 13 pectoral rays. We have not examined the type which is lodged at the Albany Museum, South Africa.

We have examined 127 specimens, 23.5 to 74.5 mm SL, including specimens from the Society Islands, Tuamotu Archipelago, Fiji Islands, Queensland, New Hebrides, New Guinea, Ambon, Philippine Islands, and Maldive Islands. De Beaufort and Briggs (1962) listed all these localities along with Samoa Islands, Santa Cruz Islands, Ponape (Caroline Islands), other East Indian Islands, Singapore, Ceylon, and Zanzibar. Smith and Smith (1963) reported it from Seychelles Islands. It has also been recorded from Taiwan by Shen and Lim (1974). In addition, we have examined specimens from Guam, Palau Islands, New South Wales, Farquhar Islands (Indian Ocean), Kenya, Tanzania, and Mozambique which constitute new distribution records. R. Kuiter (personal communication) has collected *C. bennetti* as far south as Sydney, Australia.

C. bennetti was observed by the senior author at Palau Islands and New Guinea. It was most abundant in shallow sandy areas to depths of about 10 metres. The pale coloration of the body forms an effective camouflage in this habitat. An analysis of the stomach and gut contents of three specimens (54-75 mm SL) from a single station at Samarai Island, New Guinea revealed 85% algae, 3.3% barnacle appendages, 2.6% sponge, 2.0% gastropods, 1.3% bryozoans, 1.0% foraminifera, 0.6% echuroids, 0,3% sipunculids, 0.3% polychaetes, 0.3% copepods, and 3.3% unidentified.

Canthigaster smithae n. sp.

Fig. 5C; Table 5

Canthigaster rostratus (non Bloch) Smith, 1965: 4.

HOLOTYPE: BPBM 18009, 73.0 mm SL, collected with rotenone in 30 metres off Flic en Flec, west coast of Mauritius, Indian Ocean by J. Randall on 20 November 1973.

PARATYPES: BPBM 18010, 2 specimens, 27.0 and 43.1 mm SL, collected with spear and quinaldine in 37 metres about 3 km south-west of Grand Baie, Mauritius, Indian Ocean by J. Randall on 11 November 1973; USNM 213575, 63.6 mm SL, same data as preceding specimen; RUSI 2231, 51.5 mm SL, Durban, South Africa; WAM P25126-001, 50.0 mm SL, collected with spear in 35 metres about 1.6 km north of Flic en Flec, Mauritius, Indian Ocean by J. Randall on 1 December 1973; USNM 215969, 55.5 mm SL, collected with rotenone in 20 m off north-west shore of North Island, Agalega Islands (approximately 10° 20'S, 56° 34'E) by V. Springer on 14 April 1976.

DESCRIPTION: See Table 5 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (one paratype with 9); anal rays 9; pectoral rays 17 (one paratype with 16).

Depth 2.8 (2.7 to 3.1), greatest body width 4.0 (3.6 to 4.2), head length 2.5 (2.1 to 2.4), distance from tip of snout to dorsal origin 1.4 (1.3 to 1.4), to anal origin 1.3 (1.2 to 1.4), all in standard length. Snout length 1.5 (1.6 to 1.9), eye diameter 4.3 (2.9 to 4.1), postorbital length of head 3.8 (3.5 to 5.5), least width of interorbital 3.7 (3.9 to 5.5), least depth of caudal peduncle 2.3 (2.3 to 3.5), length of caudal peduncle 1.8 (2.0 to 2.2), of dorsal fin base 4.3 (5.4 to 6.3), of anal fin base 4.7 (5.5 to 6.3), of longest dorsal ray 2.6 (2.1 to 2.5), of longest anal ray 3.1 (2.4 to 3.3), of longest pectoral ray 2.7 (2.7 to 2.9), of middle caudal rays 1.6 (1.3 to 1.6), all in head length.

Colour of holotype in alcohol: head and body generally whitish, but abruptly more or less uniform brown on dorsal surface above level of lower boundary of eye; pale portion covered with numerous small brown spots, becoming lighter on ventral surface, those in approximate longitudinal rows, one just above pectoral base and the other just below it somewhat darker giving overall appearance of a pair of longitudinal lines which extend across side to dorsal and ventral base of caudal fin; spots on region below lower jaw joining to form series of thin concentric curved lines with open side directed antero-ventrally; dark stripe sometimes present on mid-ventral line; series of spoke-like dark brown lines radiating from eye, those from opposite side not meeting over snout or interorbital, spaces between these lines white; 4-5 irregular and elongate dark-rimmed white markings extending from just below and slightly behind eye to position on sides level with distal tips of middle pectoral rays; dorsal, anal, and pectoral fins translucent with dark-edged rays, outer portion of caudal slightly dusky; prominent dark margin on dorsal and ventral edge of caudal fin.

The four largest paratypes have the same general colour scheme except the brown coloration of the back is darker and most of the spots on the sides are very faint. In addition, the 43.1 and 63.6 mm specimens exhibit a more prominent pair of longitudinal bands on the side. These bands are similar to those found in *C. rivulata*, but rather than forming an arc in front of the gill opening they continue as separate parallel bands to the snout tip. These markings are well differentiated in the largest paratype, each being composed of a whitish line with dark brown borders. The elongate dark-rimmed marks found between the eye and pectoral region of the holotype represent the remnants of this band. The 51.5 and 63.6 mm paratypes are further distinguished by the presence of a series of vertical lines on the lower side of the snout and anterior cheek region. The former specimen also possesses a series of lines on the dorsal region of the caudal peduncle which if viewed from above form V-shaped markings with the open end directed anteriorly. Also the dark margins on the caudal are faint in this specimen and are only visible on the basal part of the fin.

The 27.0 mm paratype has a poorly differentiated colour pattern. It is basically brownish on the dorsal third of the body and pale below. The small spots are not apparent, but there is a faint longitudinal brown line extending along the side below the pectoral fin. The dark caudal margins are narrow, but nevertheless discernible.

REMARKS: *C. smithae* appears to be closely related to *C. epilampra* and *C. rapaensis* from the Pacific, differing from these species primarily on the basis of colour pattern.

Named in honour of Mrs. Margaret M. Smith, Director of the J.L.B. Smith Institute of Ichthyology, Rhodes University, South Africa. Mrs. Smith assisted the junior author in making fish collection at Mauritius and also sent us one paratype of *C. smithae* collected off Durban (reported and figured as *C. rostratus* by Smith, 1965).

Canthigaster epilampra (Jenkins)
Fig. 4B

Tropidichthys epilamprus Jenkins, 1903: 486, fig. 3 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 10; anal rays 9; pectoral rays 16 to 18 (usually 17).

Depth 2.5 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.3 to 1.6, postorbital length of head 3.8 to 4.5, eye 3.6 to 4.7, interorbital 3.3 to 4.0, depth of caudal peduncle 2.2 to 2.7, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol mostly pale except brownish on dorsal portion of head and body; prominent dark brown blotch about two to three times size of eye usually present at base of dorsal fin; numerous small brown dots covering side of head and body; faint brown stripe on ventral midline from chin to anus; several diagonal brown lines emanating from mouth, about equal to eye diameter in length; 7 to 12 brown lines radiating from eye, those from opposite side not meeting over snout or interorbital; a small black-ringed white ocellus a short distance above gill opening sometimes present; several horizontal bands at caudal base slanting towards middle of fin; dorsal, anal, pectoral, and caudal fins pale. A specimen 80.6 mm SL, from Guadalcanal, Solomon Islands, lacks the dark blotch below the dorsal fin. Instead there is a series of more or less concentric dark brown lines (bluish in life) in this region.

REMARKS: *C. epilampra* differs from its closest relative *C. rapaensis* in modal dorsal fin ray count and caudal fin coloration (see remarks section for the latter species). These species, in turn are closely allied to *C. marquesensis* and *C. bennetti*. They are generally deeper bodied than *marquesensis* (Fig. 9), and tend to have a shorter caudal peduncle (Fig. 9), *C. bennetti* differs by having a less deep body (Fig. 10), a longer caudal peduncle (Fig. 10), broader interorbital (4.0 to 4.8 in SL, compared to 3.3 to 4.0 for *epilampra* and *rapaensis*), fewer pectoral rays (Table 1), and fewer spots in the caudal peduncle region (usually less than 30, while *epilamprus* generally has more than 50 sometimes faded in preservative). *C. epilampra* is also closely related to *C. smithae* from the Indian Ocean, differing mainly in colour pattern.

The type of *epilampra* (Cat. No. 50853), a specimen 70.7 mm SL from Maui is at USNM.

Fowler (1928) and Gosline and Brock (1960) were in error in placing *C. epilampra* in the synonymy of *rivulata*.

C. epilampra is usually restricted to depths below 25 metres, but is occasionally encountered in shallow water. It has previously been recorded only from the Hawaiian Islands, but we have taken it at the Society Islands, Rarotonga, Palau Islands, and the Solomon Islands. Future collections, particularly on deeper reefs, will probably reveal its presence at other Pacific localities. We examined 15 examples, 32.0 to 91.0 mm SL.

Canthigaster rapaensis n. sp.
Fig. 4C; Table 6

HOLOTYPE: BPBM 12952, 78.0 mm SL, collected with multiprong spear off south side of Ruea Point, Rapa in 13 metres by J. Randall on 9 February 1971.

PARATYPES: AMS I. 16588-001, 96.9 mm SL, same data as holotype; BPBM 12662, 84.1 mm SL, collected with multiprong spear at reef off Haurei Bay, Rapa in 25-31 metres by J. Randall on 17 February 1971; BPBM 12983, 61.0 mm SL, collected with multiprong spear on reef at entrance to Haurei Bay, Rapa in 12-15 metres by J. Randall on 18 February 1971; USNM 208277, 73.6 mm SL, collected with multiprong spear at reef off Haurei Bay, Rapa in 25-31 metres by J. Randall on 17 February 1971; USNM 208346, 81.6 mm SL, collected with multiprong spear on reef at entrance to Haurei Bay, Rapa in 12-15 metres by J. Randall on 18 February 1971.

DESCRIPTION: See Table 6 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (10 or 11); anal rays 9 (9 or 10); pectoral rays 18 (16 to 18).

Depth 2.7 (2.5 to 2.8), greatest body width 4.3 (4.0 to 4.3), head length 2.4 (2.1 to 2.5), distance from tip of snout to dorsal origin 1.3 (1.3 to 1.5), to anal origin 1.3, all in standard length. Snout length 1.5 (1.4 to 1.7), eye diameter 4.3 (3.9 to 4.9), postorbital length of head 4.2 (3.7 to 4.3), least width of interorbital 4.2 (3.9 to 4.9), least depth of caudal peduncle 2.4 (2.3 to 2.6), length of caudal peduncle 2.0 (1.7 to 2.1), of dorsal fin base 5.0 (4.5 to 5.4), of anal fin base 5.5 (4.9 to 7.5), of longest dorsal ray 2.7 (2.2 to 2.9), of longest anal ray 3.0 (2.8 to 3.5), of longest pectoral ray 2.7 (2.7 to 3.0), of middle caudal rays 1.4 (1.3 to 1.5), all in head length.

Colour of holotype in alcohol: Head and body generally pale brown; numerous small brown spots on sides of head and body; diffuse blackish patch at base of dorsal fin, larger than eye; predorsal region including dorsal portion of snout and upper rim of orbits dark brown; dark brown stripe on ventral midline extending from chin to anus; several spoke-like dark lines radiating from eye, those from opposite side not meeting over snout or interorbital; several short brown stripes (sometimes broken) on side of cheek; dorsal, anal, and pectoral fins translucent with dark-edged rays; each fin ray of caudal with three to five brown bands, membraneous portion of fin pale.

The 61.0 mm and 81.6 mm paratypes possess a small, black-ringed white ocellus a short distance above the gill opening. This feature is also present in certain individuals of *C. epilampra*.

REMARKS: *C. rapaensis* is closely related to *C. epilampra* and is probably a derivative of the ancestral stock of that species. They differ on the basis of modal dorsal ray count and colour pattern of the caudal fin. One-half of the type specimens of *C. rapaensis* possess 11 dorsal rays and the remainder have 10 rays, whereas 15 individuals of *C. epilampra* we examined possess 10 rays. The distinctive pattern of broken lines on the caudal fin exhibited by *C. rapaensis* is lacking in *C. epilampra*. For further comparison with closely related species refer to the remarks section for *C. epilampra*.

Named *rapaensis* in reference to the type locality.

Canthigaster rivulata (Schlegel)
Fig. 5A

Tetraodon rivulatus Schlegel, 1850: 285, pl. 124, fig. 3 (type locality, Nagasaki Bay, Japan).

Tetrodon caudofasciatus Günther, 1870: 304 (type locality unknown).

Eumycterus bitaeniatus Jenkins, 1901: 400, fig. 12 (type locality, Hawaiian Islands).

Canthigaster notospilus Fowler, 1941: 278, fig. 31 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 10); anal rays 9 or 10 (usually 10); pectoral rays 16 to 18 (usually 17).

Depth 2.6 to 3.0, head length 2.4 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.7, postorbital length of head 3.5 to 4.5, eye 3.3 to 5.2, interorbital 3.0 to 4.0, depth of caudal peduncle 2.2 to 2.8, length of caudal peduncle 1.7 to 2.1, of middle caudal rays 1.2 to 1.7, all in head length.

Colour in alcohol generally pale tan; side of body with two longitudinal and parallel dark bands, usually less than eye diameter in width, extending from pectoral region to caudal peduncle; bands joining each other, forming an arc in front of gill opening; lower band may be faint or absent on some specimens; dorsal portion of body (above uppermost band) with brownish vermiculated pattern; small dots or broken lines sometimes on sides of head and body; faint spoke-like lines sometimes radiating from eye; dark blotch at base of dorsal fin; dark spot on pectoral base; dorsal, anal, pectoral, and caudal fins pale.

REMARKS: *C. caudofasciatus* from the Indian Ocean is here recognized as a synonym. We have examined 31 specimens, 21.8 to 124.3 mm SL from the Somali coast of East Africa. They are essentially identical to Pacific specimens of *rivulata*. Jordan and Dickerson (1908) were the first to point out that *C. bitaeniatus* Jenkins is the young of *C. rivulata*.

The types of *rivulata*, 80-123 mm SL (catalogue numbers 1568-1571, 4653a, and 4653b) are at RMNH. Boeseman (1947) selected RMNH 4653a, a specimen 85 mm SL, as the lectotype.

We have examined 64 specimens, 21.8 to 147.0 mm SL from the Hawaiian Islands, Japan, Taiwan, South China Sea, Seychelles Islands, and Somali. Previous records include the Hawaiian Islands, Taiwan (Shen and Lim, 1974), Japan, Western Australia (McKay, 1970), Seychelles Islands (Smith and Smith, 1963), and South Africa (Smith, 1949). At the latter locality it is found to depths of at least 40 fathoms.

C. rivulata is a relatively deep dwelling species in the Hawaiian Islands, although juveniles are occasionally encountered on shallow reefs. Adults have been taken in trawl hauls from depths as great as 100 metres.

Canthigaster inframacula n. sp.

Fig. 7C; Table 7

HOLOTYPE: USNM 208483, 76.0 mm SL, collected with 12.5 metre shrimp trawl from M/V "Townsend Cromwell" in 68 to 86 fathoms off north shore of Oahu, Hawaiian Islands (21°40'N, 158°07'W) by P. Struhsaker on 12 July 1972.

PARATYPES: AMS I. 16764-001, 110.6 mm SL, same data as holotype; BPBM 15934, 2 specimens, 84.7 and 102.9 mm SL, same data as holotype.

DESCRIPTION: See Table 7 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10; anal rays 10 (10 or 11); pectoral rays 18 (17 or 18).

Depth 2.6 (2.4 to 2.8), greatest body width 4.8 (4.2 to 4.9), head length 2.6 (2.5 to 2.6), distance from tip of snout to dorsal origin 1.3, to anal origin 1.3, all in standard length. Snout length 1.7 (1.5 to 1.6), eye diameter 5.0 (4.6 to 5.9), postorbital length of head 4.2 (4.0 to 4.2), least width of interorbital 3.0 (2.9 to 3.0), least depth of caudal peduncle 2.3 (2.3 to 2.6),

length of caudal peduncle 1.9 (1.7 to 2.2), of dorsal fin base 4.7 (3.8 to 4.2), of anal fin base 4.7 (3.9 to 4.4), of longest dorsal ray 3.1 (2.6 to 3.2), of longest anal ray 2.9 (2.7 to 3.1), of longest pectoral ray 2.8 (2.7 to 3.1), of middle caudal rays 1.5 (1.5 to 1.6), all in head length.

Colour of holotype in alcohol: head and body light olivaceous grey dorsally, shading to whitish on lower sides and abdomen; a slightly irregular blackish stripe from eye to upper base of caudal fin (diffuse just behind eye); an irregular roundish black spot larger than eye on lower side between pectoral base and origin of anal fin; head and body except thorax and abdomen with well-separated small brownish to blackish spots, most numerous dorsally on snout; brownish lines radiating anteriorly, dorsally, and posteriorly from eye; a few brownish lines also present dorsally at front of snout, on nape, back, and dorsally on caudal peduncle; dorsal, anal, and pectoral fins translucent, slightly yellowish; dorsal and anal base with brownish lines and small brown spots; caudal fin pale with faint brownish spots arranged in approximately vertical rows.

The paratypes are similarly patterned except the stripe behind the eye of the largest paratype is very faint and nearly indistinguishable posterior to the level of the dorsal fin. The large dark spot on the lower sides is also faint in this specimen.

REMARKS: The fin ray counts, colour pattern, and large size attained indicate a relationship to C. *callisterna* and C. *rivulata*. The black spot on the lower sides, on which the specific name is based, is particularly diagnostic for this species. Although C. *inframacula* is presently known only from the Hawaiian Islands, it is possible that it will be found at other Pacific Islands. Deeper water collections are wholly lacking for most of Oceania.

Named *inframacula* in reference to the diagnostic black spot on the lower half of the body.

Canthigaster callisterna (Ogilby)
Fig. 5B and Fig. 11

Tetrodon callisternus Ogilby, 1889: 74, pl. 3, fig. 5 (type locality, Lord Howe Island).

DIAGNOSIS: Dorsal rays 11; anal rays 10 or 11 (usually 10); pectoral rays 17 or 18 (usually 18).

Depth 2.8 to 3.2, head length 2.4 to 2.8, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.4, all in standard length. Snout 1.6 to 1.8, postorbital length of head 3.7 to 4.4, eye 3.8 to 4.7, interorbital 3.0 to 3.7, depth of caudal peduncle 2.6 to 2.9, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.3 to 1.5, all in head length.

Colour in alcohol reddish brown dorsally, whitish ventrally; dorsal portion of body (above eye level) covered with small dark spots, connecting to form maze of broken lines on mid-dorsal surface; head usually with about 12 brownish lines radiating from eye; snout and predorsal region with numerous irregular dark lines, cheeks with series of oblique dark lines, whitish ventral region overlaid with light brown spots, the largest about equal to pupil size; many specimens (all sub-adults below about 50-60 mm SL) with whitish longitudinal band (with spots) on middle of sides, about equal to eye diameter in width, extending from snout to base of caudal fin (see Fig. 12); margins of band darker than surrounding body region giving appearance of two faintish stripes; usually an imperfect ocellus formed of concentric broken lines at base of dorsal fin; dorsal, anal, and pectoral fins pale; caudal fin pale with series of faint bars, upper and lower margins of fin dark brown.

REMARKS: C. *callisterna* and C. *rivulata*, the two largest species in the genus, are closely related. Colour pattern and the dorsal fin ray count constitute the principle differences between the two species (Table 1).

The syntypes of *callisterna* (AMS I. 1485 and I. 1965), 2 specimens, 82.0 and 140.0 mm SL from Lord Howe Island, were examined by G.R.A. We have seen 30 specimens, 36.3 to 225.0 mm SL, from New South Wales, Lord Howe and Norfolk islands. Whitley (1968) reported it from northern New Zealand, the Kermadec Islands, and New South Wales.

Canthigaster janthinoptera (Bleeker)
Fig. 6A

Tropidichthys janthinopterus Bleeker, 1855: 429 (type locality, Ambon).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 9); anal rays 9 or 10 (usually 9); pectoral rays 16 to 18 (usually 17).

Depth 2.2 to 2.6, head length 2.4 to 2.6, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.6, postorbital length of head 3.6 to 4.3, eye 4.1 to 4.7, interorbital 3.0 to 3.8, depth of caudal peduncle 1.8 to 2.3, length of caudal peduncle 1.9 to 2.5, of middle caudal rays 1.3 to 1.5, all in head length.

Colour in alcohol brownish with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; head usually with spoke-like lines radiating from eye; dark blotch or ocellus sometimes present (sometimes poorly developed) at base of dorsal fin; caudal fin uniform tan to brownish; remainder of fins translucent with rays thinly outlined with dark pigment. The orange stripes on the side of the head of the illustrated specimen from Lord Howe Island (Fig. 6A) is a variable feature which appears in some adults.

REMARKS: *C. janthinoptera*, *C. jactator*, and *C. punctatissima* form a close-knit complex, differing from each other primarily with regards to colour pattern. The latter species are apparently derived from the former. It is difficult to determine if *C. jactator* and *C. punctatissima* have evolved to the species level. However, it is our opinion that these populations are adequately isolated geographically and exhibit sufficient colour pattern differences to merit this distinction. The most useful features for separating these species are the size and number of pale spots which cover the body, presence or absence of either lines radiating from the eye or a dark spot or ocellus at the base of the dorsal fin and caudal fin coloration. *C. jactator* from the Hawaiian Islands generally has larger (about equal to pupil) and less numerous pale spots on the head and body. These usually number about 8-11 in an approximate vertical row from the dorsal origin to the anal origin, while *C. janthinoptera* (Indo-W. Pacific) and *C. punctatissima* (eastern Pacific) generally have more than 12 (usually 14 to 17). Specimens of *C. janthinoptera* from the Line Islands and south-east Oceania frequently have spot patterns similar to *jactator*, but unlike that species they usually exhibit either an ocellus (may be only partially developed) or dark spot at the base of the dorsal fin and poorly developed lines or "spokes" which radiate from the eye. Many examples from this region possess both features. Four of 19 specimens from the Seychelles Islands possessed an ocellus, and all had well developed eye spokes. The dorsal base ocellus and eye spokes are also lacking in *C. punctatissima*. This species further differs from both *janthinoptera* and *jactator* by having pale spots on the caudal fin. These are a continuation of the spot pattern on the body and are most apparent on the basal portion of the fin.

The type of *janthinoptera* (RMNH 7359), a flattened and discoloured specimen (33.0 mm SL) from Ambon was examined by J.E.R.

We have examined 89 specimens, 26.3 to 62.2 mm SL, from Pitcairn Island, Oeno Atoll, Mangareva, Marquesas Islands, Society Islands, Austral Islands, Cook Islands, Marshall

Islands, Wake Island, Solomon Islands, Fiji Islands, New Hebrides, Queensland, Lord Howe Island, Chagos Archipelago, Seychelles Islands, Madagascar, Tanzania, Mozambique, and South Africa. Most of these localities represent new records. It was previously reported from Ponape (Caroline Islands), New Hebrides, Philippine Islands, Ambon, Sula Islands, Celebes, and Comores by De Beaufort and Briggs (1962). In addition, it has been recorded from the Seychelles Islands (Smith and Smith, 1963), Taiwan (Shen and Lim, 1974), and the Marshall Islands (as *C. jactator*; Woods, in Schultz *et al.*, 1966). We have also recently collected specimens at Western Australia and the Maldive Islands which represent new locality records.

Canthigaster jactator (Jenkins)
Fig. 6B

Tropidichthys jactator Jenkins, 1901: 399, fig. 1 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 9); anal rays 9 or 10 (usually 9); pectoral rays 16 to 18 (usually 17).

Depth 2.3 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.1 to 1.3, all in standard length. Snout 1.4 to 1.7, postorbital length of head 3.8 to 4.6, eye 3.6 to 4.8, interorbital 3.1 to 3.9, depth of caudal peduncle 1.8 to 2.2, length of caudal peduncle 1.7 to 2.4, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol brown with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; caudal fin uniform tan to brownish; remainder of fins translucent with rays thinly outlined with dark pigment.

REMARKS: Refer to the preceding remarks section for a discussion of the relationship between *C. jactator, C. janthinoptera* and *C. punctatissma.*

The type of *jactator* (catalogue number 49703), a specimen 41.9 mm SL from Oahu, is at USNM.

This species, which is confined to the Hawaiian Islands, is the most common shallow water member of the genus found there. An analysis of the stomach and gut contents of 18 specimens (43-65 mm SL) from five stations off Oahu revealed 37.6% sponges, 21.9% algae (mixed with sand and detritus), 13.7% tunicates (mostly didemnids), 7.5% bryozoans, 3.5% polychaetes, 2.7% ophiuroids, 2.2% gastropods, 1.1% foraminifera, 1.1% echinoids, 1.0% coral, 0.8% sipunculoids, 0.8% pelecypods, 0.7% crabs, 0.5% fish, 0.3% tubeworms, 0.1% amphipods, and 3.5% unidentified.

Canthigaster punctatissima (Günther)
Fig. 12

Tetrodon punctatissimus Günther, 1870: 302 (type locality, Pacific coast of Panama).

Tetrodon oxyrhynchus Lockington, 1881: 116 (type locality, Gulf of California).

Canthigaster punctatissimus reticulatus Breder, 1937: 50 (type locality, Baja, California).

Canthigaster brederi Whitley, 1959: 323 (substitute name for *punctatissimus reticulatus* Breder).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 to 10 (usually 9); pectoral rays 15 to 18 (usually 17).

Depth 2.3 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.7, postorbital length of head 3.7 to 4.7,

The paratypes from the Indian Ocean are similar except there is some variability in the pattern of lines on the interorbital and pre-dorsal portion of the back. In addition, the intensity of the large spots on the sides is variable, particularly in life, ranging in colour from dark brown to orange-brown. All specimens have a circular design on the nape which in the paratypes is surrounded by a maze of fine dark lines. The corss-bars on the snout and lines on the interorbital-predorsal are more prominent in the specimen from the Maldive Islands.

The 58.0 mm paratype from Ambon, Indonesia has fewer and larger spots on the body. In addition, the large dark spots are absent on the head except a single vertical row immediately anterior to the pectoral base. The ventral portion of the head and body is profusely covered with faint spots arranged roughly in a band extending from the chin to the anal base. In life these spots were bluish and the ground colour of the band was yellow. The area surrounding the eye was also yellow with prominent blue lines radiating from the orbit.

REMARKS: This species is morphologically similar to C. *solandri* and C. *margaritatus*, but differs greatly in colour pattern. The prominent peak on the nape is also a significant feature which is not found on most of the species of the genus.

C. *tyleri* is known from the Molucca Islands, Maldive Islands, Comoro Islands, and Mauritius. Further collecting, particularly in deeper water, will probably yield additional specimens from other localities in the Indian Ocean and Indo-Malayan region.

Named in honour of Dr. James C. Tyler, who sent us the first specimen from the Comoro Islands which is now designated as a paratype.

Canthigaster pygmaea n. sp.
Fig. 15; Table 9

HOLOTYPE: BPBM 18012, 30.3 mm SL, collected with emulsified rotenone in 3 metres about 100 metres south of marine lab at Eilat, Israel, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 24 September 1974.

PARATYPES: BM(NH) 1975. 1.13.1-2, 2 specimens, 27.3 and 28.0 mm SL, collected with emulsified rotenone in 21 metres ½ km north of Fjord, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 26 September 1974; BPBM 17875, 37.0 mm SL, collected with spear in 6 metres at Harvey Reef about 19 km south of Port Sudan, Red Sea by J. Randall on 10 October 1974; BPBM 17876, 2 specimens, 37.0 and 38.5 mm SL, collected with rotenone in 6-20 metres on fringing reef front about 500 metres north of entrance to Port Sudan Harbour, Red Sea by J. Randall on 15 October 1974; CAS 31792, 23.1 mm SL, collected with emulsified rotenone in 2 metres at Ras Muhammed, off southern end of Sinai Peninsula, Red Sea by J. Randall, O. Gon, and A. Levy on 19 September 1974; CAS 31793, 5 specimens, 28.0-38.0 mm SL, collected with rotenone in 0-3 metres at bay between Marsa Mokrakh and El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 15 July 1969; HUJ F. 4756, 3 specimens, 30.0-40.8 mm SL, collected at Ras Muhammed, Red Sea on 7 August 1968: HUJF. 7005, 2 specimens, 30.0 and 32.0 mm SL, collected at Ras El Hameirah, Gulf of Aqaba, Red Sea on 17 December 1967; HUJ F. 7006, 2 specimens, 29.5 and 32.5 mm SL, same data as preceding specimens; HUJ F. 7007, 10 specimens, 23.1-39.1 mm SL, collected at Gulf of Smithonia, Gulf of Aqaba, Red Sea on 26 June 1967; HUJ F. 7008, 4 specimens, 25.7-29.5 mm SL, collected at same locality as preceding specimens on 30 August 1967; MNHN 1975-3, 25.6 mm SL, collected with emulsified rotenone in 15 metres about 1 km north of Coral Island, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 23 September 1974; SMF 13227, 4 specimens, 13.0-30.0 mm SL, collected with rotenone in 25-30 metres at El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 9 September 1969; USNM 212284, 13 specimens, 23.9-33.5 mm SL, collected with rotenone in 5

eye 3.7 to 5.0, interorbital 3.1 to 3.6, depth of caudal peduncle 1.8 to 2.4, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol brown with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; caudal fin tan to brownish with small pale spots (may be faded in preservative), particularly apparent on basal portion of fin; remainder of fins translucent with rays thinly outlined with dark pigment.

REMARKS: Refer to the remarks section for *C. janthinoptera* for a discussion of the relationship between *C. punctatissima*, *C. jactator* and *C. janthinoptera*.

The type of *punctatissimus*, a specimen 70.0 mm SL from Panama is at BM(NH).

We have examined 36 specimens, 12.7 to 67.0 mm SL, from the Gulf of California, Pacific coast of Mexico, Costa Rica, Panama, Revillagigedo Islands, Clipperton Island, and Galapagos Islands.

Canthigaster tyleri n. sp.

Fig. 6C; Table 8

HOLOTYPE: BPBM 18014, 63.4 mm SL, collected with rotenone in 30 metres off Flic en Flec, west coast of Mauritius, Indian Ocean by J. Randall on 20 November 1973.

PARATYPES: ANSP 109816, 33.5 mm SL, collected with rotenone on west side of fringing reef off Grande Comore Island, Comoro Islands (11° 41′33″S, 43° 14′27″E) in 0-25 metres by scientific party of *Anton Bruun* on 27 November 1964; BM(NH) 1974. 3.11.8, 45.9 mm SL, collected with rotenone among coral and rubble at entrance to large cave in 20 metres at Bandos Island, North Male Atoll, Maldive Islands by R. Lubbock and J. Serpell on 15 July 1973; BPBM 18011, 49.2 mm SL, collected with emulsified rotenone at Cathedral Reef, off Flic en Flec, Mauritius by J. Randall and D. Pelicier on 25 November 1973; BPBM 18042, 52.2 mm SL, collected with spear at entrance to cave off south side of Villingili Island, Maldive Islands in 32 metres by J. Randall on 17 March 1975; WAM P25169-001, 58.0 mm SL, collected with rotenone off Latuhalat, S.E. coast of Ambon, Molucca Islands, Indonesia in 40 metres by G. Allen and J. Randall on 29 January 1975.

DESCRIPTION: See Table 8 for measurements of the types. The counts and pproportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9; anal rays 9; pectoral rays 16 (16 or 17).

Depth 2.7 (2.7 to 3.1), greatest body width 4.6 (4.3 to 4.6), head length 2.5 (2.2 to 2.5), distance from tip of snout to dorsal origin 1.4 (1.3), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout length (1.6 to 1.7), eye diameter 4.3 (3.3 to 5.1), postorbital length of head 4.2 (4.2 to 4.8), least width of interorbital 3.3 (3.6 to 4.8), least depth of caudal peduncle 1.5 (2.2 to 2.7), length of caudal peduncle 1.8 (2.0 to 2.7), of dorsal fin base 5.1 (4.8 to 6.5), of anal fin base 5.1 (5.1 to 6.2), of longest dorsal ray 4.3 (2.8 to 4.5), of longest anal ray 3.3 (3.1 to 3.5), of longest pectoral ray 3.2 (2.7 to 3.2), of middle caudal rays 1.4 (1.4 to 1.7), all in head length.

Colour of holotype in alcohol: head and body light tan, paler ventrally; dark brown spots about size of pupil or smaller covering sides of head and body; belly with scattered whitish spots; snout with 7-8 narrow brown cross-bars dorsally, the anterior ones entirely encircling snout; eye with radiating brown lines; series of thin brown lines forming hexagonal and circular designs on interorbital and pre-dorsal regions; fins pale with dark-edged rays.

metres at reef near road off Marsa Mugabila, northwest coast of Gulf of Aqaba, Red Sea by V. Springer on 17 July 1969; USNM 212287, 23 specimens, 22.5-36.4 mm SL, collected with rotenone in 12 metres near Ras Burqa, northwest coast of Gulf of Aqaba, Red Sea by V. Springer on 23 July 1969; USNM 212286, 15.6 mm SL, collected with rotenone in 20-23 metres at Ras Muhammed, Red Sea by V. Springer on 28 September 1969; WAM P25124-001, 35.7 mm SL, collected with holotype; WAM P25125-001, 2 specimens, 17.2-31.3 mm SL, collected with rotenone in 25-30 metres at El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 9 September 1969.

DESCRIPTION: See Table 9 for measurements of selected types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9 (8 to 10); anal rays 9 (9 or 10); pectoral rays 15 (14 to 16).

Depth 2.5 (2.5 to 2.8), greatest body width 4.3 (3.3 to 4.9), head length 2.2 (2.0 to 2.4), distance from tip of snout to dorsal origin 1.3 (1.1 to 1.3), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout length 1.7 (1.6 to 1.9), eye diameter 4.4 (3.5 to 4.4), postorbital length of head 4.4 (3.8 to 5.2), least width of interorbital 4.5 (3.8 to 4.8), least depth of caudal peduncle 2.6 (2.1 to 2.9), length of caudal peduncle 2.1 (1.7 to 2.5), of dorsal fin base 5.2 (4.9 to 7.2), of anal fin base 6.8 (4.9 to 7.2), of longest dorsal ray 3.1 (2.5 to 4.8), of longest anal ray 3.6 (2.9 to 3.6), of longest pectoral ray 3.0 (2.7 to 3.7), of middle caudal rays 1.5 (1.3 to 1.4), all in head length.

Colour of holotype in alcohol: head and body generally grey-brown, slightly lighter on ventral surface; numerous small round spots on side, those over most of body faintly grey with dark dot in centre, those on ventral surface and lowermost portion of side prominently dark; dark brown spot, about size of eye or slightly smaller at base of dorsal fin; most of eye except anterior edge broadly rimmed with dark brown; side of snout and cheek with 9 narrow grey bars with dark outlines, not joining those from opposite side across dorsal surface of snout; fins pale with dark-edged rays.

The paratypes are similar in coloration, but vary greatly with respect to the intensity of the spots on the side and bars on the head. In many individuals these are solidly dark and more prominent than those exhibited by the holotype. The number of bars on the head is also variable, ranging from about 4-9.

REMARKS: This species appears to be related to the *C. janthinoptera* complex (i.e., *C. janthinoptera*, *C. jactator*, *C. punctatissima* and *C. tyleri*). It is clearly distinct on the basis of its colour pattern and unusually small size. In addition, it differs from the other members of the complex and most *Canthigaster* by its low pectoral ray count which is nearly always 15.

This species is apparently confined to the Red Sea at depths ranging from two to at least 25-30 metres, usually in the vicinity of caves.

Named *pygmaea* with reference to the very small size. The gonads of several specimens were examined revealing mature ova in females of only 25 mm SL.

Canthigaster amboinensis (Bleeker)
Fig. 7A

Psilonotus amboinensis Bleeker, 1865: 180 (type locality, Ambon).

Tropidichthys psegma Jordan and Evermann, 1903: 209 (type locality, Hawaiian Islands).

Tropidichthys oahuensis Jenkins, 1903: 485, fig. (type locality, Hawaiian Islands).

Canthigaster polyophthalmus Pietschmann, 1938: 51, pl. 1, fig. c (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 10 to 12 (usually 12); anal rays 10 or 11 (usually 11); pectoral rays 16 or 17 (usually 17).

Depth 2.3 to 2.5, head length 2.4 to 2.9, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.1 to 1.3, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.5 to 4.1, eye 3.8 to 5.4, interorbital 2.9 to 3.6, depth of caudal peduncle 2.0 to 2.5, length of caudal peduncle 1.6 to 2.0, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally brown; head and sides with numerous pale spots with dark centres; snout crossed by several dark lines; eye with several dark lines radiating from the posterior edge and arching dorsally, not joining those of opposite side; cheeks with parallel rows of small blackish dots forming lines which curve ventrally towards throat; dorsal, anal, and pectoral fins blackish at base, remainder of fin pale brown or reddish; caudal fin brown.

REMARKS: The usual combination of 12 dorsal and 11 anal rays serves to separate *amboinensis* from all other *Canthigaster.* Small juveniles (under about 35 mm SL) are similar in appearance to *C. janthinoptera.* Pietschmann's (1938) description of *C. polyophthalmus* is based on a juvenile *amboinensis,* 33 mm SL.

Bleeker based his description of this species on two examples, 95 and 114 mm TL. RMNH obtained one specimen (Cat. No. 7361) 76 mm SL (95 mm TL) at the auction of Bleeker's collections in 1879. It is apparently one of the syntypes and was examined by J.E.R. The remaining syntype is missing.

C. amboinensis is a wide-ranging species which occurs throughout the tropical Indo-Pacific region and has penetrated the eastern Pacific. We have examined 38 specimens, 26.0 to 106.5 mm SL, from the Hawaiian Islands, Line Islands, Marquesas Islands, Society Islands, Samoa Islands, Marshall Islands, New Hebrides, Solomon Islands, New Britain, Ambon, Queensland, Christmas Island (Indian Ocean), Seychelles Islands, Comoro Islands, and Mauritius. Most of these localities represent new records except the Hawaiian Islands, Samoa Islands, Seychelles Islands, and Ambon which were listed by De Beaufort and Briggs (1962). In addition, they recorded *C. amboinensis* from the Fiji Islands, Gilbert Islands, Japan, Philippine Islands, New Guinea, and Natal. Hobson and Walters (1968) recorded it from the Galapagos Islands and Shen and Lim (1974) reported it from Taiwan. We provisionally identify a 30.2 mm specimen from Durban, South Africa as *C. amboinensis* although it may represent a juvenile *C. natalensis.* It differs from that species, however, by having 12 dorsal rays and lacks dark markings on the chin and mid-ventral line. In addition, there are no cross-bars on the snout and interorbital.

This species is usually encountered in very shallow water, frequently in the lower reaches of the surge zone. It is one of the faster swimming members of the genus. An analysis of the stomach and gut contents of four specimens (50-80 mm SL) from four stations off Oahu, Hawaiian Islands revealed 43.6% algae (mixed with detritus), 12.7% polychaetes, 12.0% echinoids, 8.2% ophiuroids, 4.8% tunicates (mostly didemnids), 4.7% gastropods, 3.7% coral, 2.1% pelecypods, 0.8% amphipods, 0.5% sponge, 0.4% foraminifera, 0.3% sipunculids, and 3.2% unidentified.

Canthigaster natalensis (Günther)

Fig. 7B

Tetrodon amboinensis var. *natalensis* Günther, 1870: 303 (type locality, Natal).

DIAGNOSIS: Dorsal rays usually 11 (8 in one specimen); anal rays 10 or 11; pectoral rays 16 or 17 (usually 16).

Depth 2.5 to 2.7, head length 2.5 to 2.6, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.7, postorbital length of head 3.5 to 3.8, eye 3.8 to 6.8, interorbital 3.2 to 3.7, depth of caudal peduncle 2.1 to 2.7, length of caudal peduncle 1.8 to 2.1, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol of three specimens, 69-83 mm SL, from Mauritius, Indian Ocean generally brown, lighter on ventral surface; numerous white spots, about 1/3 to ½ pupil size, on side and also faintly visible on basal half of caudal fin; small dark spots of similar size widely scattered among pale spots, but not particularly apparent due to brown ground colour; side of snout with series of 4-7 dark bars joining those from opposite side on dorsal surface; 2-3 similar lines sometimes joined to former, but perpendicular to them in orientation, on lower part of head extending from lower jaw to level of gill opening; dark blotch or lines usually present on chin; dark stripe (sometimes broken) on mid-ventral line from posterior part of head to anus; edge of eye with several dark lines radiating in all directions, those on dorsal part meeting opposite members on interorbital; cheeks with patch of small white spots, sometimes coalesced to form irregular broken lines; dorsal, anal, and pectoral fins whitish with dark-edged rays; caudal fin dusky to brownish. Two specimens, 52 and 104 mm SL, from the southern coast of East Africa are similar, but lack white spots on the side, although numerous dark ones are present. Perhaps this alteration in colour is due to the action of preservation. In addition, the smaller specimen possesses several dark vertical lines on the cheek, just below the eye.

REMARKS: *C. natalensis* is closely allied to *C. amboinensis*, from which it is perhaps derived. Although we have not examined a sufficient number of *C. natalensis* (see Table 1) there appears to be significant differences in the dorsal and pectoral ray counts between these species. *C. amboinensis* nearly always possess 12 dorsal rays whereas the normal complement for *C. natalensis* appears to be 11. The latter species usually has 16 pectoral rays compared with 17 for *C. amboinensis*. Furthermore, there are significant colour differences (Fig. 7).

Günther (1870) described *C. natalensis* as a subspecies or variety of *C. amboinensis*, but he only examined one individual. We have not examined the type specimen which is lodged at the British Museum, but Günther's brief description is diagnostic, particularly his mention of short horizontal and vertical lines on the side of the head and spots on the basal half of the caudal fin.

We have examined five specimens, 52.0-104.0 mm SL, from Reunion, Mauritius, Mozambique and Durban Bay, South Africa. Three of these were collected at Mauritius by J.E.R. at depths ranging from three to 10 metres.

Canthigaster investigatoris (Annandale and Jenkins)
Fig. 13 and 14

Tropidichthys investigatoris Annandale and Jenkins, 1910: 16, pl. 1, fig. 4 (type locality, Andaman Islands).

DIAGNOSIS: Dorsal rays 9 or 10; anal rays 10; pectoral rays 15.

The following proportions are from one of the two syntypes, 40.7 mm SL. Figures in parentheses represent the measurement in millimetres. Depth 2.8 (14.3), head length 2.2 (18.6), tip of snout to dorsal origin 1.2 (33.1), to anal origin 1.3 (32.2), all in standard length. Snout 2.1 (9.0), postorbital length of head 4.0 (4.7), eye 3.4 (5.4), interorbital 4.0 (4.6), depth of caudal peduncle 3.3 (5.7), length of caudal peduncle 2.6 (7.2), of middle caudal rays 1.5 (12.5), all in head length.

Colour in alcohol uniformly tan with several narrow brown lines crossing snout and interorbital; 2-3 similar lines extending horizontally from upper caudal peduncle and dorsal fin base to pectoral region; fins tan, probably translucent in life.

REMARKS: The colour pattern in combination with the low pectoral ray count are distinctive characters. It is probably allied to C. *bennetti,* but differs appreciably with regards to colour and depth distribution.

This species is known on the basis of only two syntypes dredged from a depth of 55 fathoms off the Andaman Islands, Indian Ocean. One of these (ZSI F437/1), a specimen, 40.7 mm SL, was examined by G.R.A.

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Fig. 1. A. *Canthigaster solandri*, 52mm SL, Marshall Islands.
B. *Canthigaster solandri*, 74mm SL, Marshall Islands.
C. *Canthigaster solandri*, 67mm SL, Palau Islands.

Fig. 2. A. *Canthigaster margaritata*, 74mm SL, Gulf of Aqaba, Red Sea.
B. *Canthigaster compressa*, 57mm SL, Solomon Islands.
C. *Canthigaster bennetti*, 66mm SL, Palau Islands.

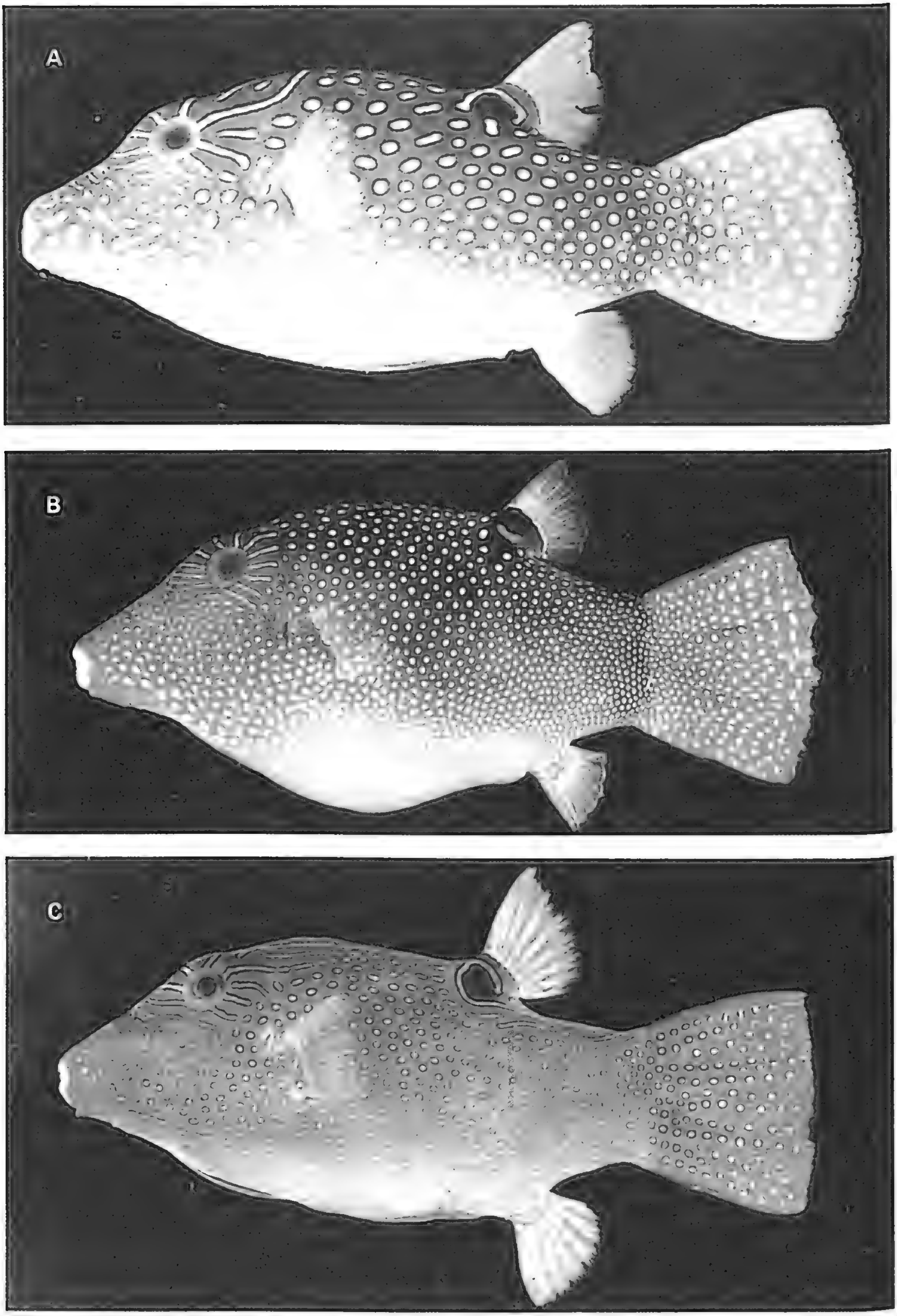
Fig. 3. A. *Canthigaster valentini*, 55mm SL, Great Barrier Reef.
B. *Canthigaster ocellicincta*, holotype, 50mm SL, Solomon Islands.
C. *Canthigaster coronata*, 54mm SL, Japan.

Fig. 4. A. *Canthigaster marquesensis*, holotype, 70mm SL, Marquesas Islands.
B. *Canthigaster epilampra*, 69mm SL, Hawaiian Islands.
C. *Canthigaster rapaensis*, holotype, 78mm SL, Rapa, Austral Islands.

Fig. 5. A. *Canthigaster rivulata*, 128mm SL, Japan.
B. *Canthigaster callisterna*, 225mm SL, Lord Howe Island.
C. *Canthigaster smithae*, holotype, 73mm SL, Mauritius.

Fig. 6. A. *Canthigaster janthinoptera*, 59mm SL, Lord Howe Island.
B. *Canthigaster jactator*, 36mm SL, Hawaiian Islands.
C. *Canthigaster tyleri*, holotype, 65mm SL, Mauritius.

Fig. 7. A. *Canthigaster amboinensis*, 58mm SL, Society Islands.
B. *Canthigaster natalensis*, 86mm SL, Mauritius.
C. *Canthigaster inframacula*, holotype, 76mm SL, Hawaiian Islands.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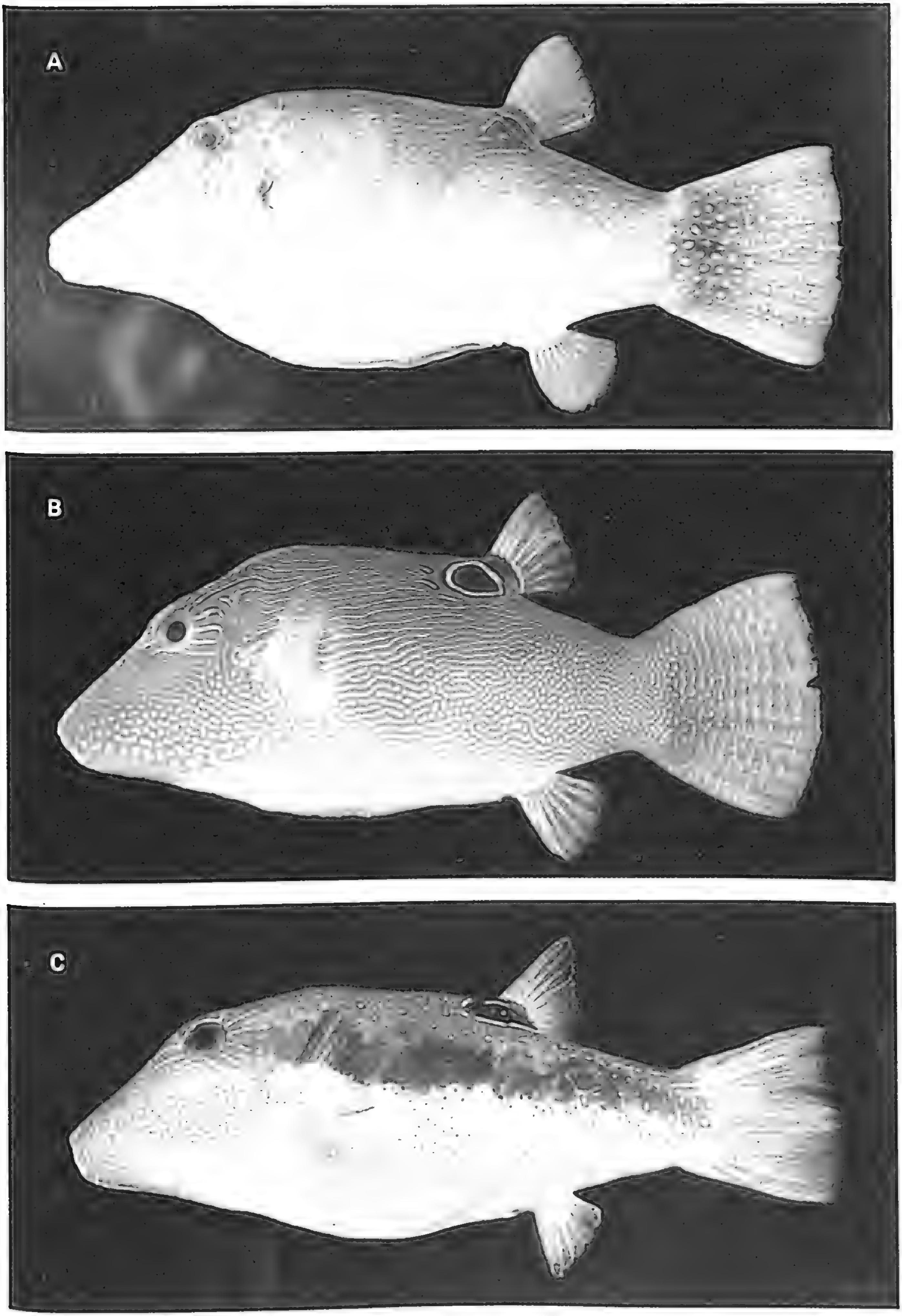
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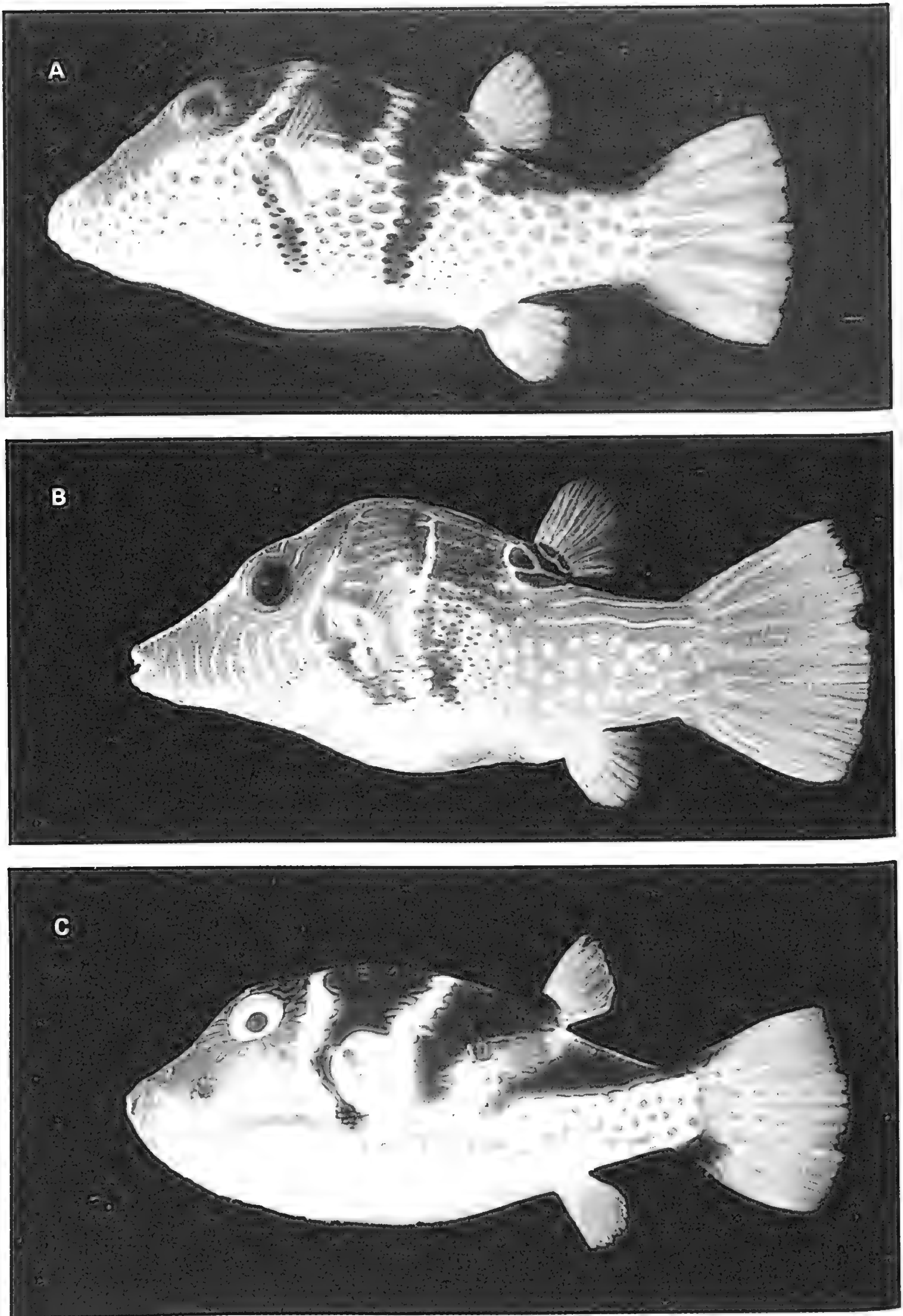
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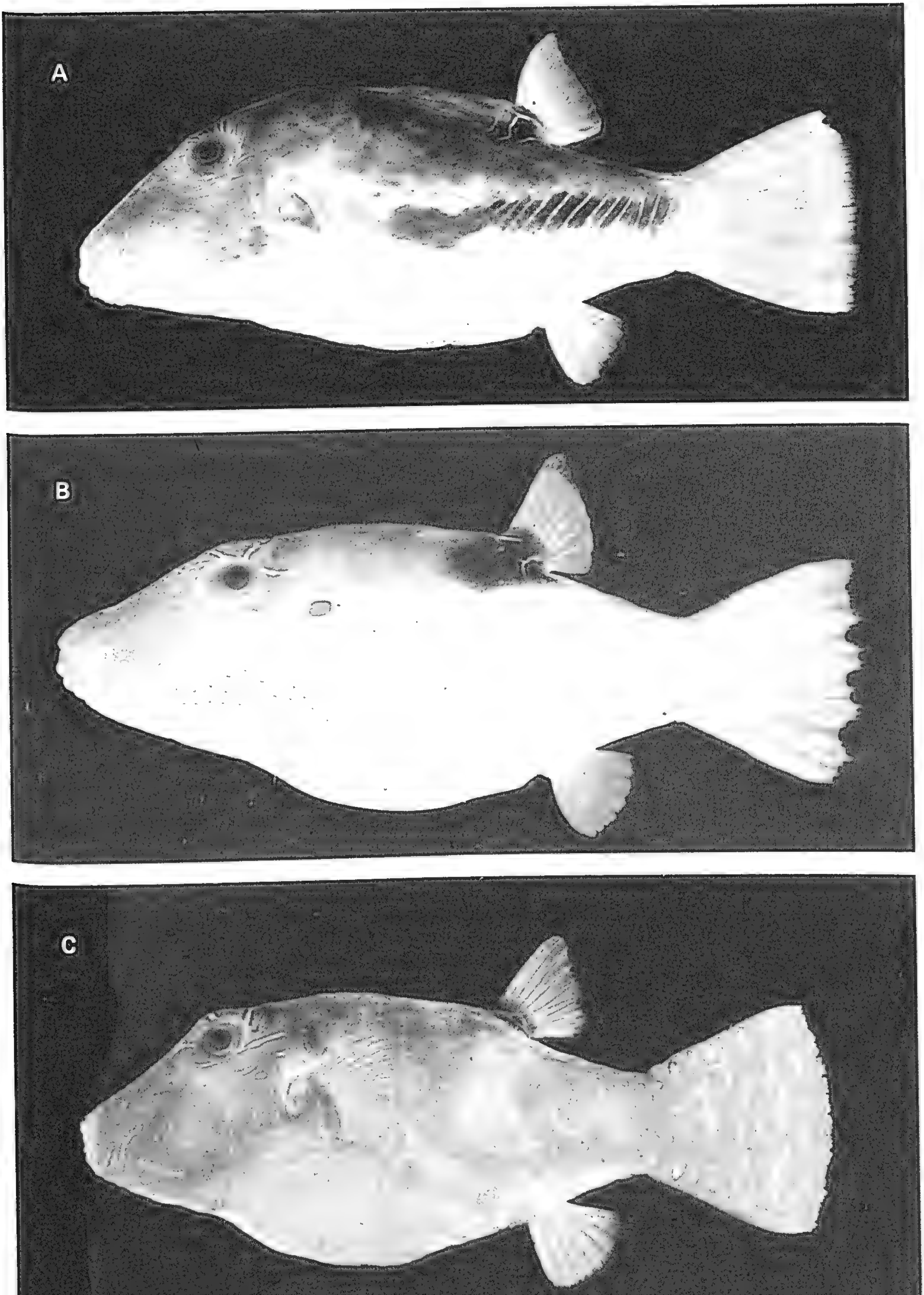
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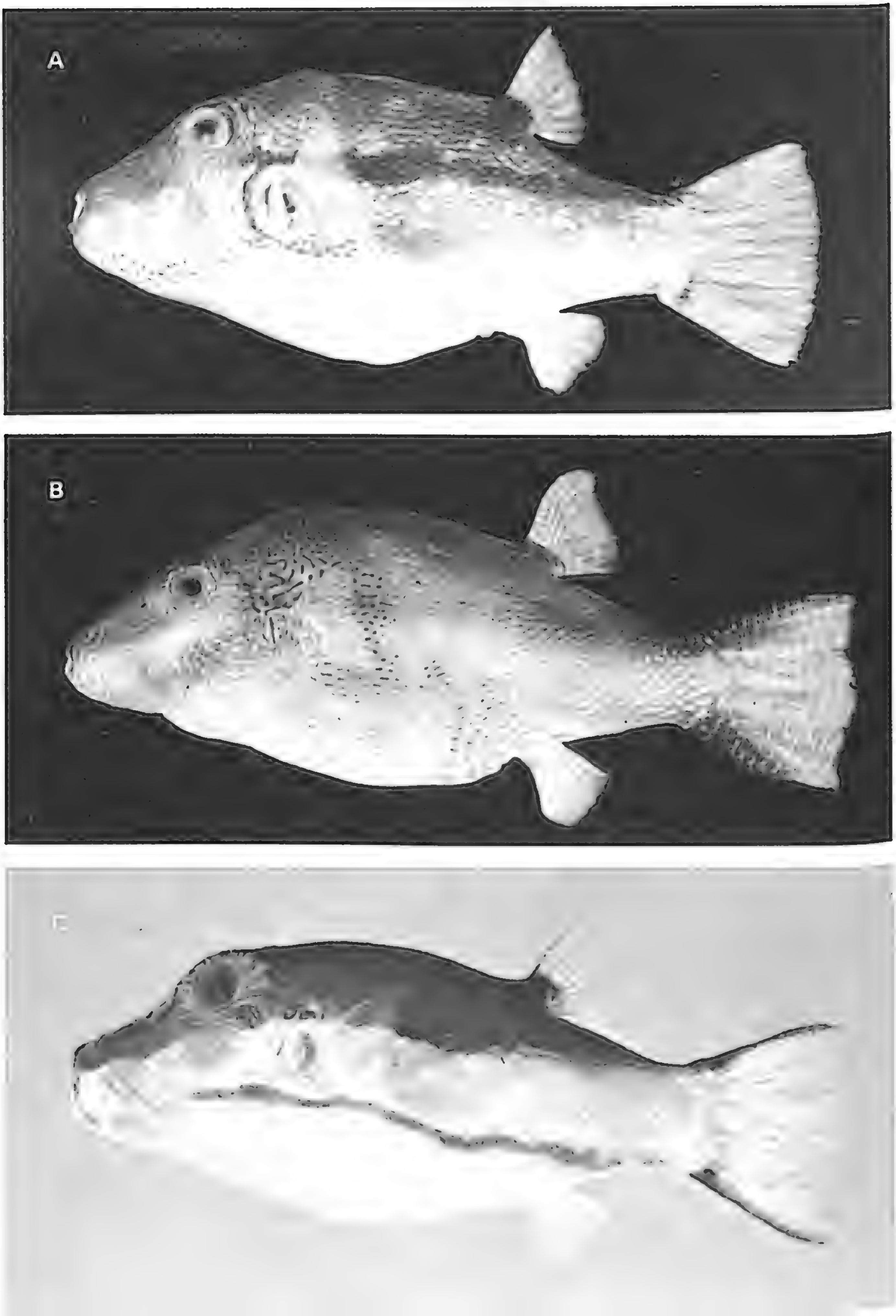
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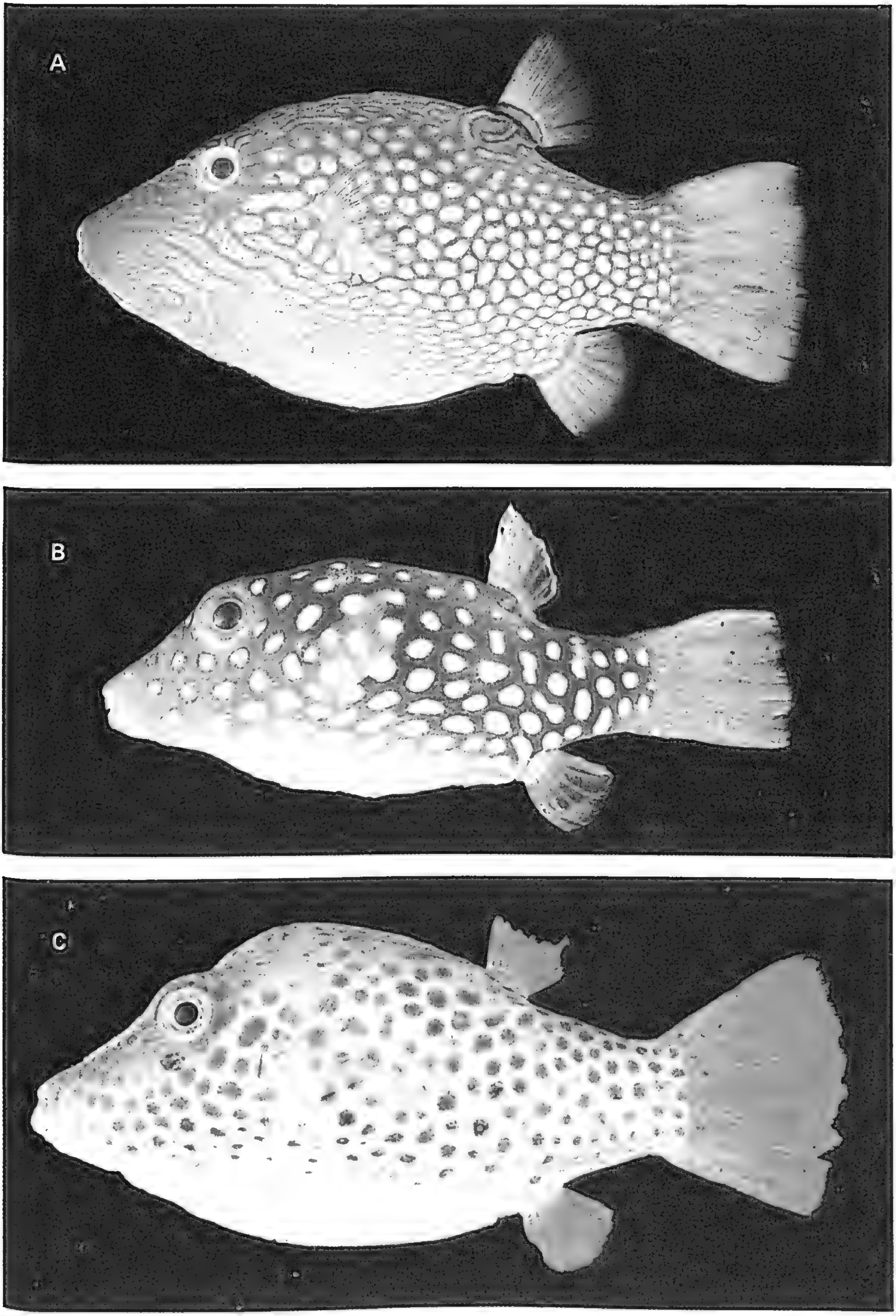
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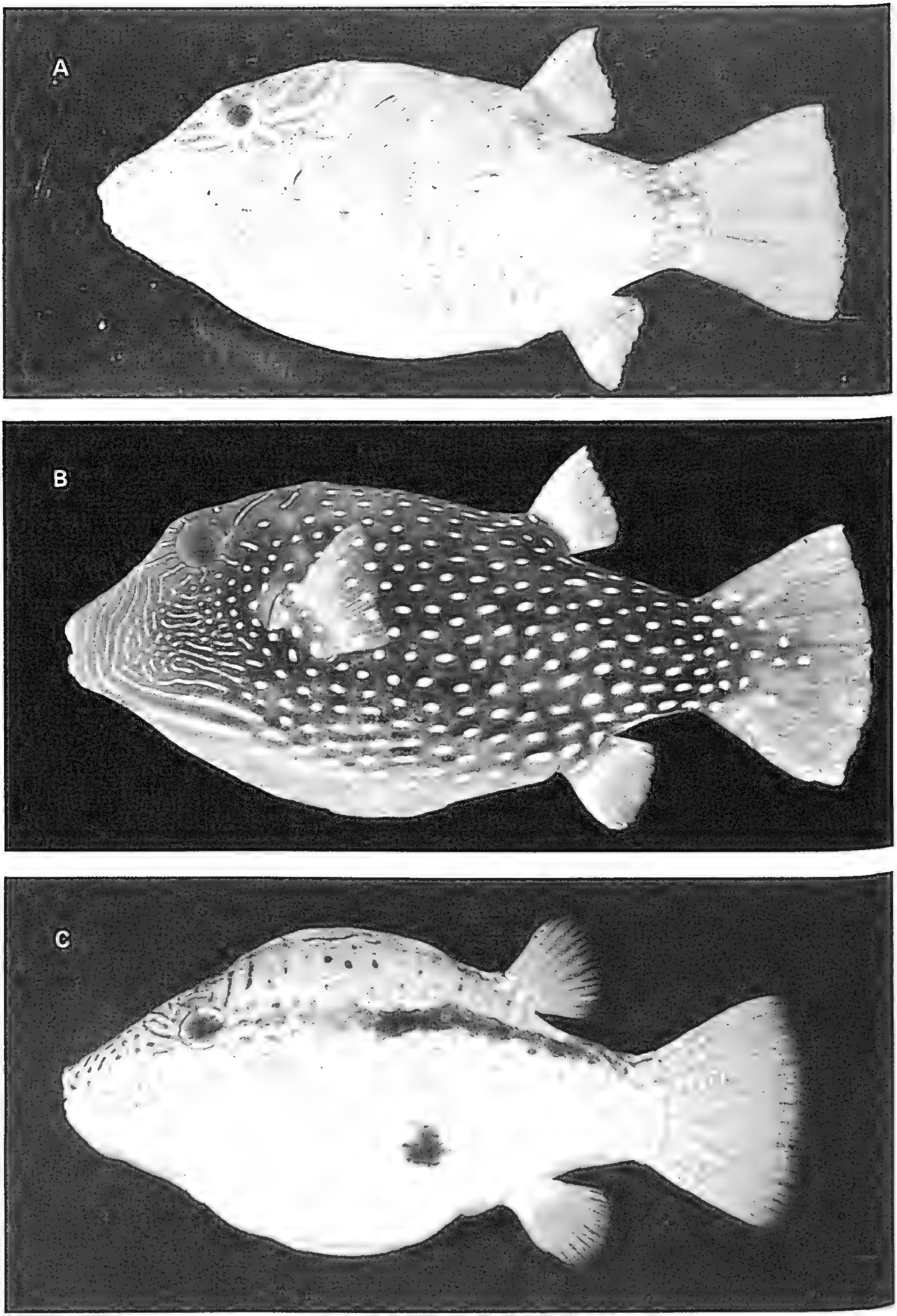
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Table 1. Fin Ray Counts For Species Of *Canthigaster* From The Indo-Pacific

	Dorsal					Anal				Pectoral				
Species	8	9	10	11	12	8	9	10	11	14	15	16	17	18
amboinensis			1	6	19			5	21			5	21	
bennetti		34	46	1		4	75	2		1	49	31		
callisterna			2	16				17	1			1	12	4
compressa	5	65	13			6	77				2	35	40	6
coronata		1	17			1	12	5				5	12	1
epilampra			15			1	14					1	11	3
inframacula			4					3	1				2	2
investigatoris		1	1					2			2			
jactator		14	3				16	1				1	12	4
janthinoptera	2	67	10			2	74	3			1	16	53	9
margaritata	18	3				19	2					1	18	2
marquesensis		2	11				13						12	1
natalensis	1			4				2	3			4	1	
ocellicincta		5					5					5		
punctatissima	3	18	3			5	18	1				3	19	2
pygmaea	3	42	1				44	2		2	41	3		
rapaensis			3	3			5	1				1	3	2
rivulata		5	52				6	51				5	46	6
smithae		1	5				6					1	5	
solandri	3	117	22			9	132	1			2	42	92	
tyleri		5					5					4	1	
valentini		12					12					11	1	

Table 2. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster ocellicincta*

Morphometric measurement	Holotype BPBM 15933	AMS I. 17500-001	Paratypes MNHN 1975-2	USNM 211299	WAM P25283-004
Standard length (mm)	50.1	42.3	35.7	33.4	28.0
Body depth	391	407	356	371	336
Greatest body width	240	222	221	228	250
Head length	427	411	448	443	479
Snout length	269	270	255	272	282
Eye diameter	104	113	140	135	129
Interorbital width	126	121	109	99	104
Least depth of caudal peduncle	204	182	165	180	154
Length of caudal peduncle ...	198	203	182	174	179
Snout to dorsal origin	772	766	759	796	804
Snout to anal origin	796	780	798	796	796
Length of dorsal fin base	84	87	67	78	71
Length of anal fin base	80	78	56	69	64
Longest dorsal ray	156	163	157	159	171
Longest anal ray	134	135	132	150	143
Length of pectoral fin	132	154	148	150	146
Length of caudal fin	343	340	336	344	357

Table 3. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster marquesensis*

Morphometric measurement	Holotype BPBM 11129	BPBM 11109	BPBM 11145	Paratypes BPBM 11126	AMS I. 11678-001	USNM 208267
Standard length (mm)	69.6	89.0	82.1	71.9	62.8	53.4
Body depth	352	340	366	344	344	371
Greatest body width	265	227	238	195	247	275
Head length	371	369	387	373	369	388
Snout length	246	253	272	239	245	264
Eye diameter	86	82	91	76	96	94
Interorbital width	91	84	102	90	84	92
Least depth of caudal peduncle	157	148	152	145	151	165
Length of caudal peduncle ...	230	226	231	234	252	234
Snout to dorsal origin	741	721	743	727	731	747
Snout to anal origin	754	755	771	776	783	777
Length of dorsal fin base	80	66	73	68	76	79
Length of anal fin base	72	66	62	58	61	62
Longest dorsal ray	155	140	158	157	151	172
Longest anal ray	105	107	116	129	115	135
Length of pectoral fin	134	124	138	122	140	150
Length of caudal fin	270	239	256	261	271	315

Table 4. Fin Ray Counts Of *Canthigaster bennetti* From Different Localities

Locality	Dorsal 9	Dorsal 10	Dorsal 11	Anal 8	Anal 9	Anal 10	Pectoral 14	Pectoral 15	Pectoral 16
Society Islands	3	13			15	1		6	10
Tuamotus	1	3		1	3			2	2
Guam	2	3			5			2	3
Palau		1			1			1	
New Guinea	1	1	1		3			2	1
New Hebrides	3	8		1	10			5	6
Farquhar Islands	5	2			6	1	1	6	
East Africa	19	15		2	32			25	9
TOTALS	34	46	1	4	75	2	1	49	31

Table 5. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster smithae*

Morphometric measurement	Holotype BPBM 18009	Paratypes USNM 213575	Paratypes RUSI 2231	Paratypes WAM P25126-001	Paratypes BPBM 18010	Paratypes BPBM 18010
Standard length (mm)	73.0	63.6	51.5	50.0	43.1	27.0
Body depth	362	319	353	364	348	352
Greatest body width	251	244	282	242	232	230
Head length	403	415	427	432	425	467
Snout length	268	245	256	272	251	244
Eye diameter	93	102	120	110	118	159
Interorbital width	108	91	108	106	97	85
Least depth of caudal peduncle	178	157	175	184	158	133
Length of caudal peduncle	219	197	194	220	200	156
Snout to dorsal origin	719	747	777	720	731	759
Snout to anal origin	785	774	816	780	740	833
Length of dorsal fin base	95	71	80	80	72	81
Length of anal fin base	85	71	78	76	72	74
Longest dorsal ray	155	164	186	186	188	219
Longest anal ray	130	126	155	140	174	178
Length of pectoral fin	147	149	151	160	155	163
Length of caudal fin	258	261	330	310	332	333

Table 6. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster rapaensis*

Morphometric measurement	Holotype BPBM 12952	Paratypes AMS I. 16588-001	BPBM 12662	USNM 208346	USNM 208277	BPBM 12983
Standard length (mm)	78.0	96.9	84.1	81.6	73.6	61.0
Body depth	372	408	363	368	359	377
Greatest body width.........	233	237	213	233	251	238
Head length	412	402	392	417	398	413
Snout length................	269	270	268	278	268	248
Eye diameter................	96	83	86	99	95	105
Interorbital width	96	102	100	85	90	85
Least depth of caudal peduncle	172	165	155	172	170	161
Length of caudal peduncle...	205	236	214	208	193	216
Snout to dorsal origin	749	741	672	717	709	738
Snout to anal origin	776	757	773	772	792	785
Length of dorsal fin base.....	82	74	87	81	76	77
Length of anal fin base	74	73	68	81	53	72
Longest anal ray.............	154	138	139	147	156	187
Length of pectoral fin	138	116	119	123	129	148
Length of caudal fin	295	279	269	276	281	328

Table 7. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster inframacula*

Morphometric measurement	Holotype USNM 208483	Paratypes AMS I. 16764-001	BPBM 15934	BPBM 15934
Standard length (mm)	76.0	110.6	102.9	84.7
Body depth	388	402	422	354
Greatest body width..............	205	226	234	201
Head length	392	383	398	387
Snout length.....................	234	260	248	237
Eye diameter....................	79	65	72	85
Interorbital width	132	127	136	130
Least depth of caudal peduncle ...	170	165	164	151
Length of caudal peduncle........	203	230	238	179
Snout to dorsal origin	779	770	788	797
Snout to anal origin	783	761	780	779
Length of dorsal fin base..........	83	101	97	92
Length of anal fin base	84	99	93	86
Longest dorsal ray................	128	147	126	130
Longest anal ray..................	134	142	129	133
Length of pectoral fin	141	131	127	142
Length of caudal fin	268	253	260	240

Table 8. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster tyleri*

Morphometric measurement	Holotype BPBM 18014	Paratypes WAM P25169-001	BPBM 18011	BM(NH) 1974.3.11.8	ANSP 109816
Standard length (mm)	63.4	58.0	49.2	45.9	33.5
Body depth	375	379	370	349	322
Greatest body width	219	245	234	229	218
Head length	402	426	443	458	427
Snout length	256	248	268	281	254
Eye diameter	93	107	87	102	128
Interorbital width	121	117	112	102	90
Least depth of caudal peduncle	260	190	193	187	161
Length of caudal peduncle	218	216	187	181	188
Snout to dorsal origin	740	750	762	795	770
Snout to anal origin	782	784	803	830	812
Length of dorsal fin base	79	84	91	85	66
Length of anal fin base	79	83	83	85	69
Longest dorsal ray	*	152	142	*	134
Longest anal ray	121	122	128	*	158
Length of pectoral fin	126	155	146	153	137
Length of caudal fin	287	300	289	275	301

* *damaged*

Table 9. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster pygmaea*

Morphometric measurement	Holotype BPBM 18012	Paratypes USNM 212287	WAM P25124-001	USNM 212284	HUJ 7006	HUJ 7008
Standard length (mm)	30.3	36.3	34.2	32.8	29.5	26.1
Body depth	403	369	404	396	353	395
Greatest body width	234	273	205	305	251	268
Head length	446	433	424	473	468	494
Snout length	261	264	240	274	261	261
Eye diameter	102	118	96	116	112	142
Interorbital width	99	107	108	122	98	107
Least depth of caudal peduncle	168	165	199	186	163	172
Length of caudal peduncle	215	215	243	253	190	215
Snout to dorsal origin	792	774	766	793	905	801
Snout to anal fin origin	792	804	743	793	814	774
Length of dorsal fin base	86	80	85	91	64	69
Length of anal fin base	66	80	73	88	68	69
Longest dorsal ray	142	91	155	149	156	172
Longest anal ray	132	138	129	128	129	146
Length of pectoral fin	149	129	149	152	132	153
Length of caudal fin	300	309	313	335	336	352

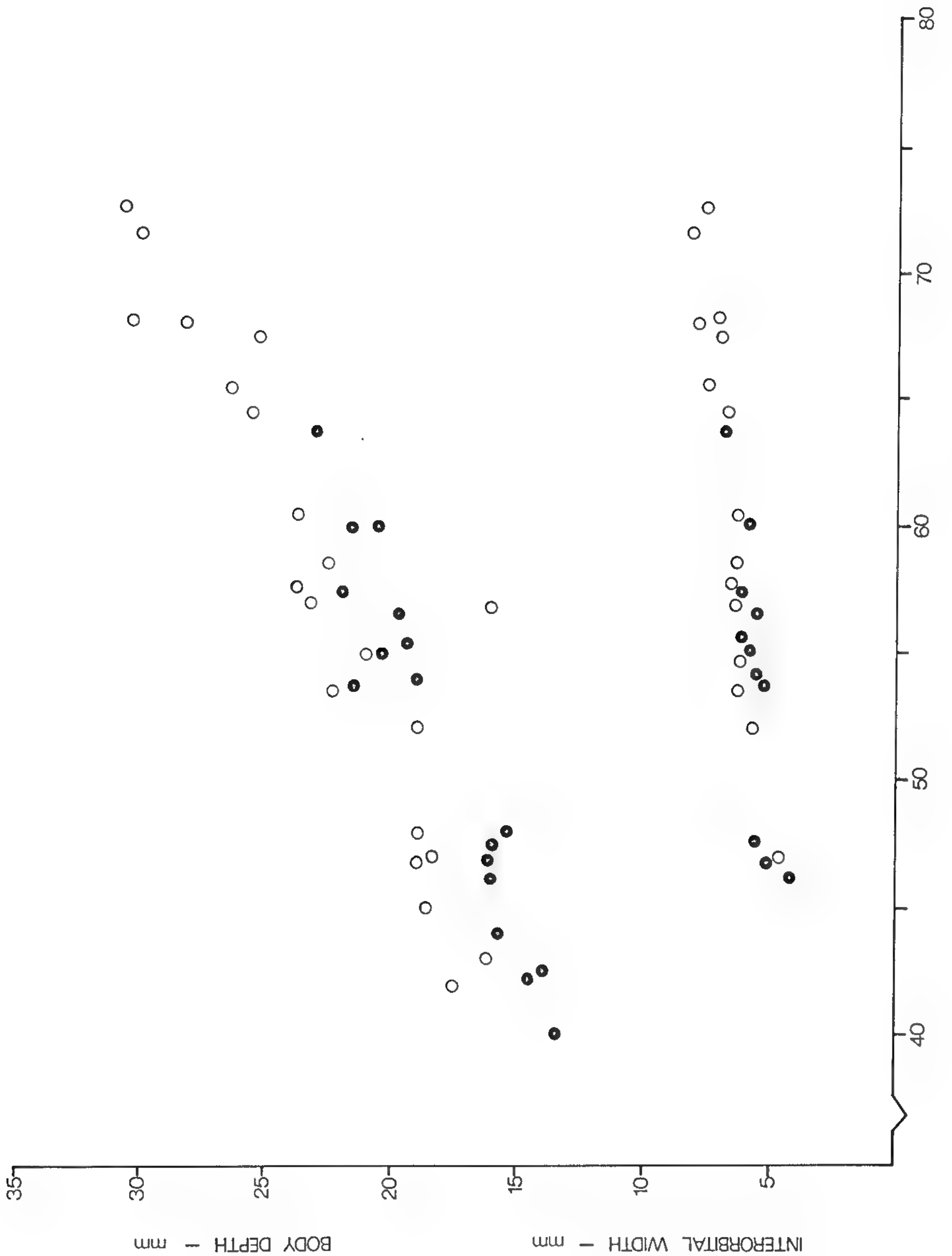

Fig. 8. Comparison of body depth (upper) and interorbital width (lower) with standard length for *Canthigaster margaritata* (solid dots) and *C. solandri* (hollow circles).

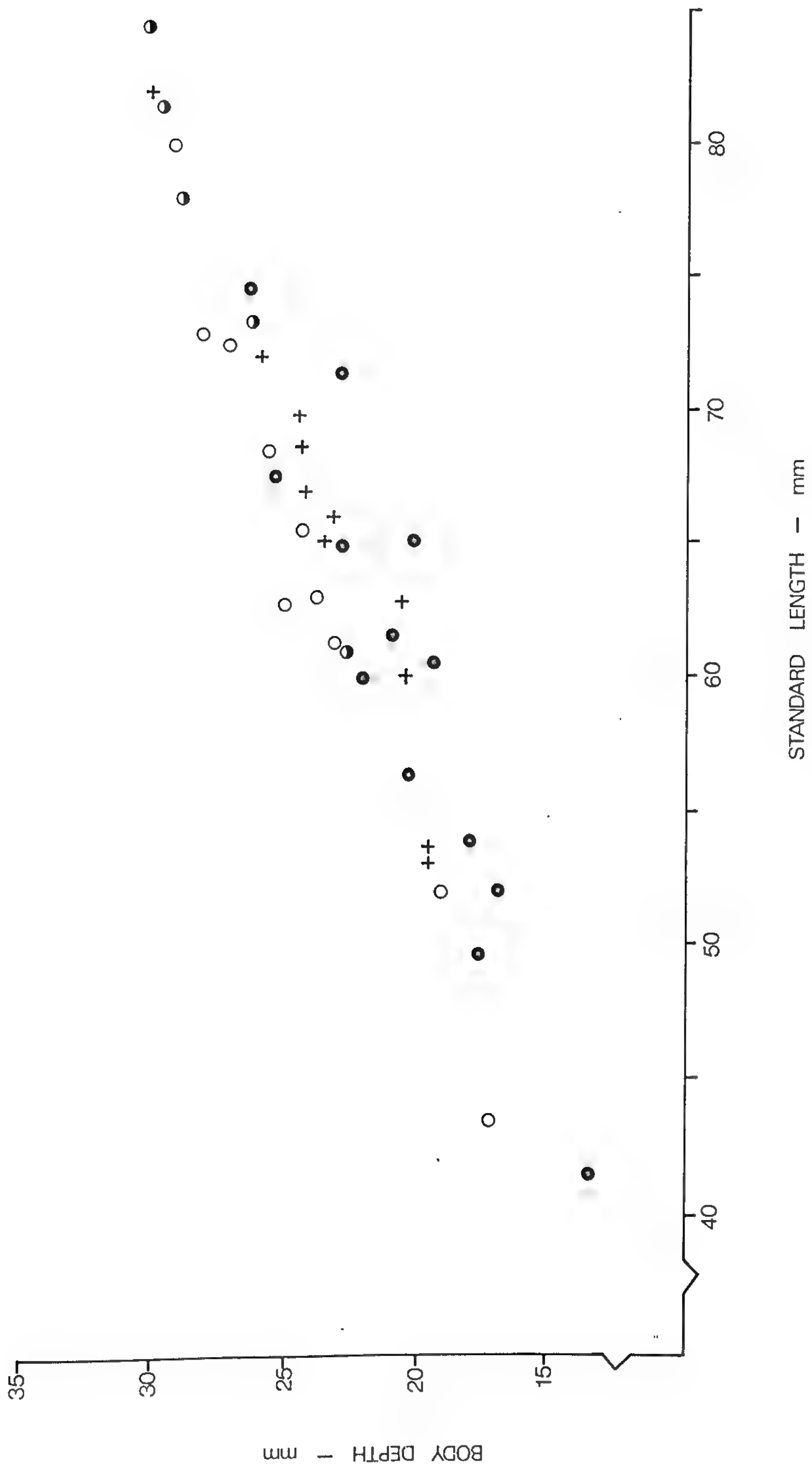

Fig. 9. Comparison of body depth with standard length for *Canthigaster bennetti* (solid dots), *C. epilampra* (hollow circles), *C. marquesensis* (crosses), and *C. rapaensis* (half-black circles).

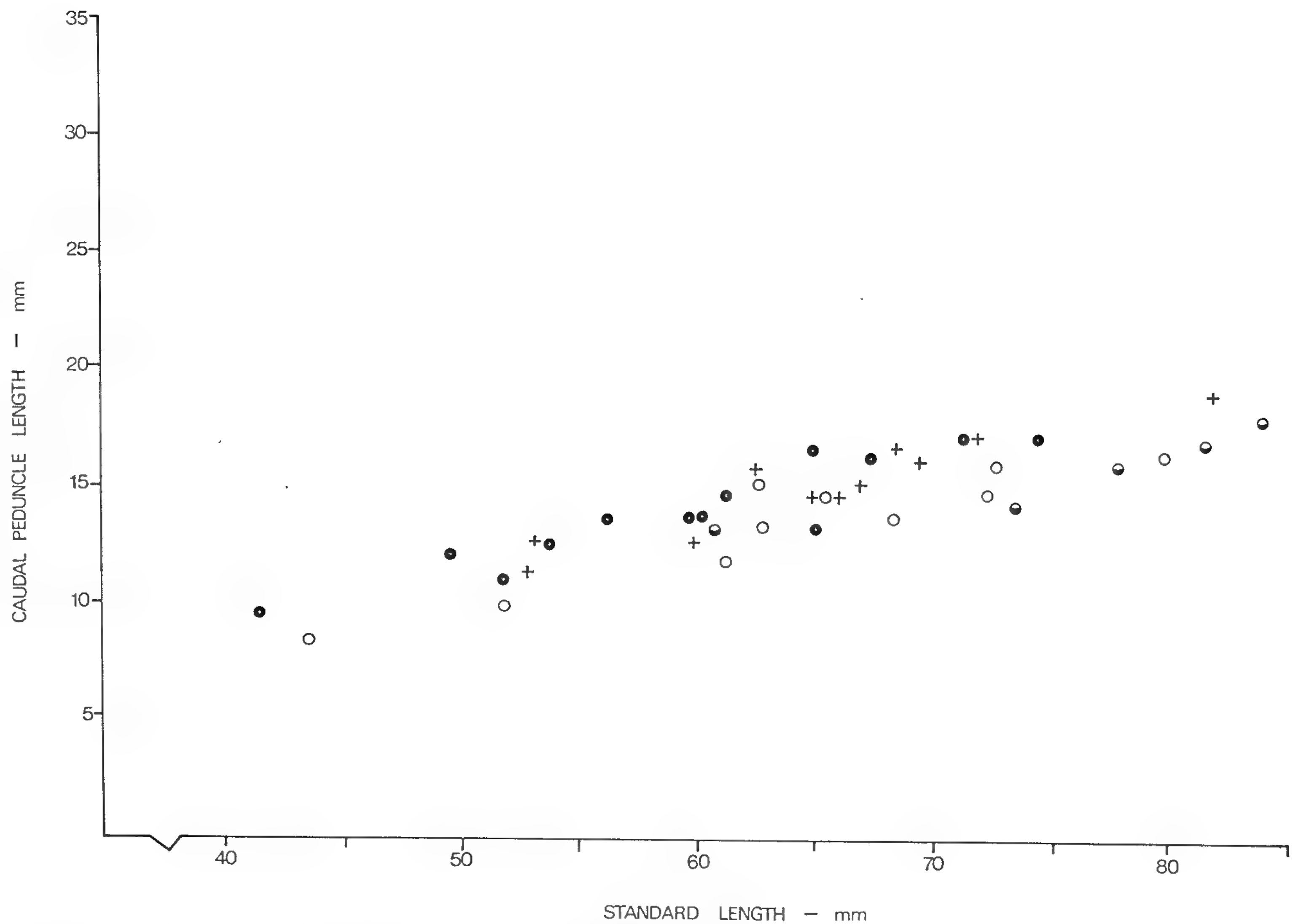

Fig. 10. Comparison of caudal peduncle length with standard length for *Canthigaster bennetti* (solid dots), *C. epilampra* (hollow circles), *C. marquesensis* (crosses), and *C. rapaensis* (half-black circles).

ERRATUM. This sheet replaces page 513 in Records of the Australian Museum, Volume 30 Number 17.

Fig. 11. Underwater photograph of juvenile of *Canthigaster callisterna*, 50 mm SL, Sydney, NSW. (R. Kuiter photo).

Fig. 11. Underwater photograph of juvenile of *Canthigaster callisterna*, 50 mm SL, Sydney, NSW. (R. Kuiter photo).

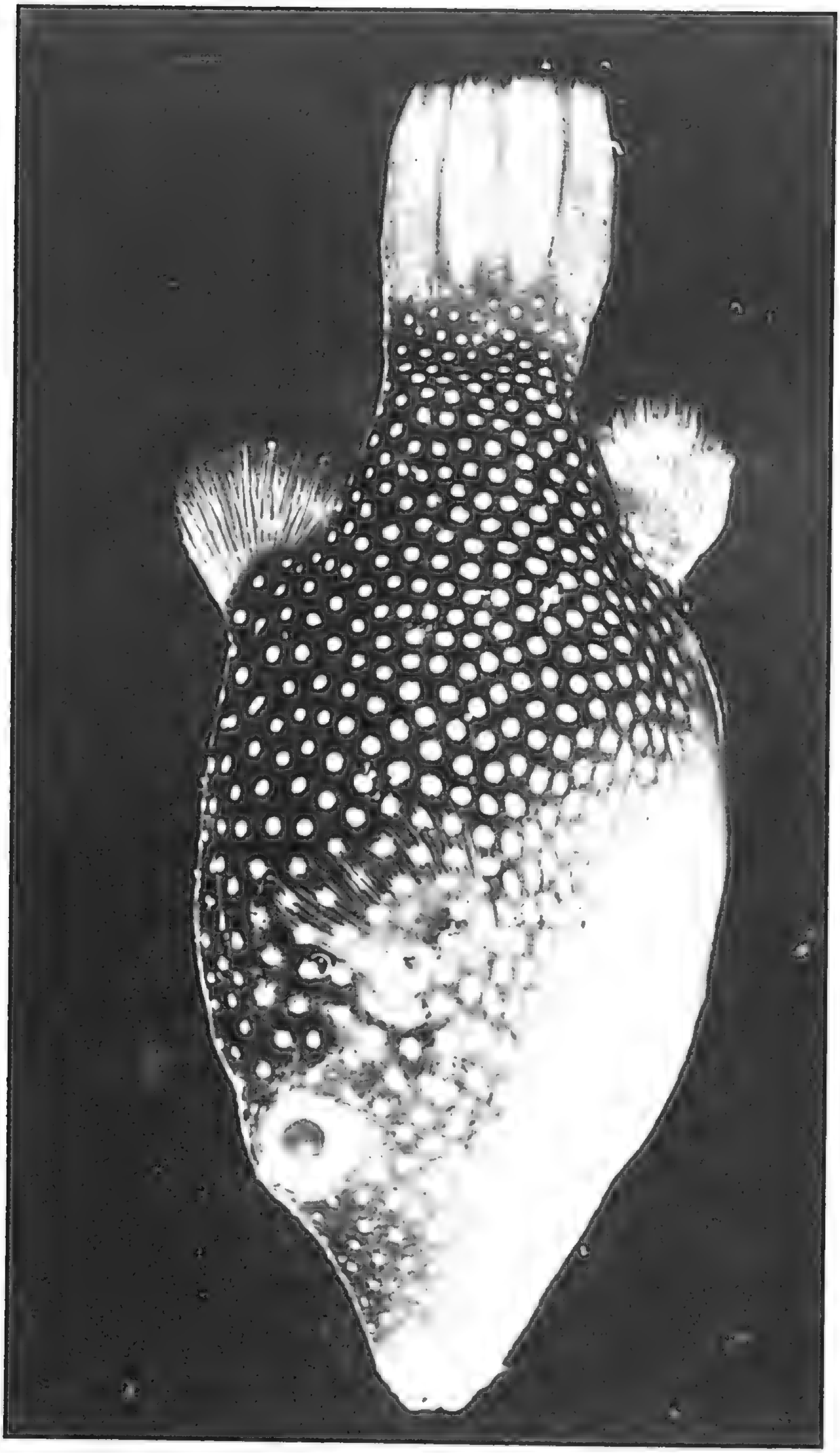

Fig. 12. *Canthigaster punctatissima,* 40 mm SL, Panama.

Fig. 13. *Canthigaster investigatoris*, syntype, 40.7 mm SL, Andaman Islands.

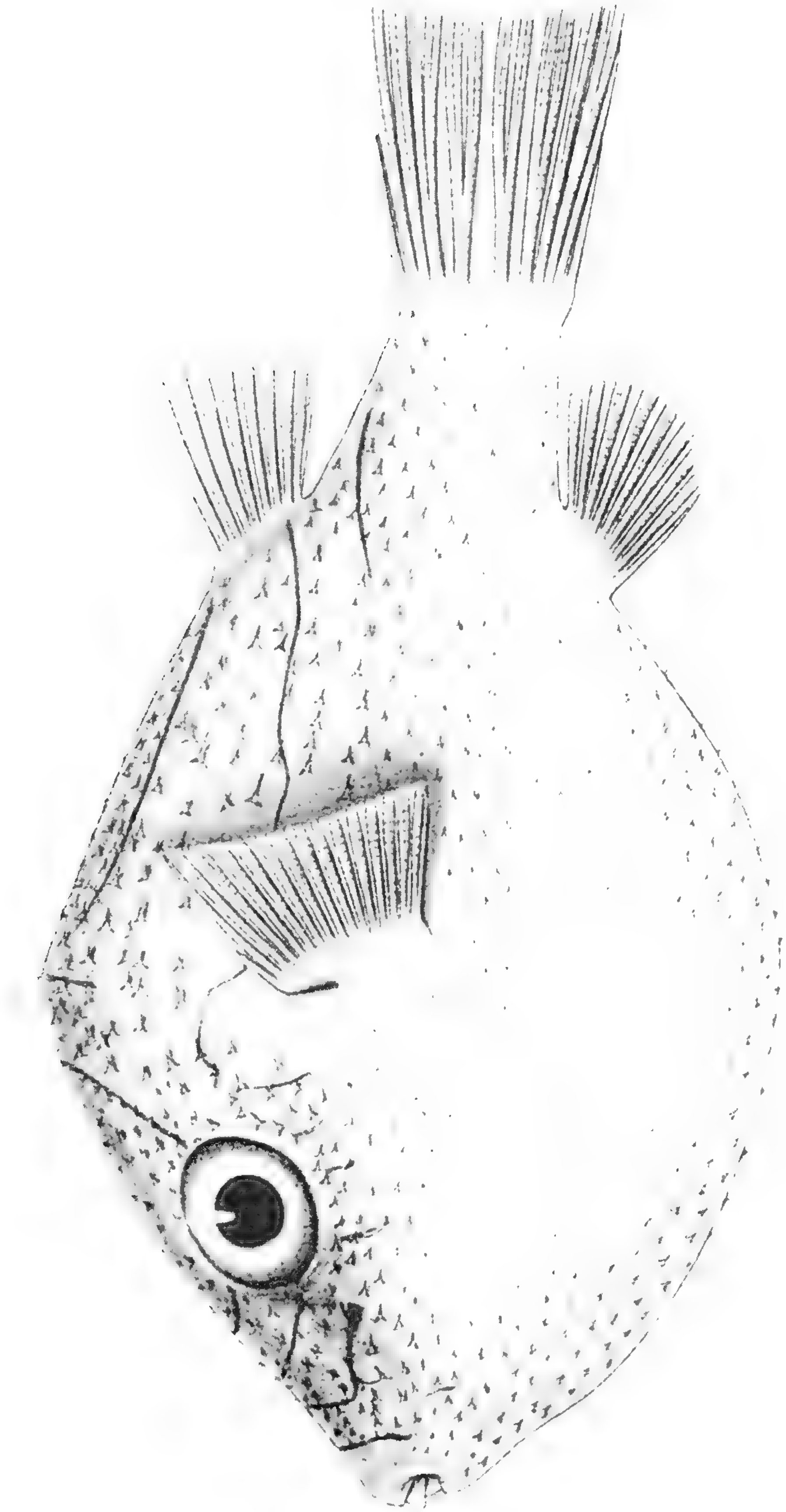

Fig. 14. *Canthigaster investigatoris*, drawing of syntype (from Annandale and Jenkins, 1910).

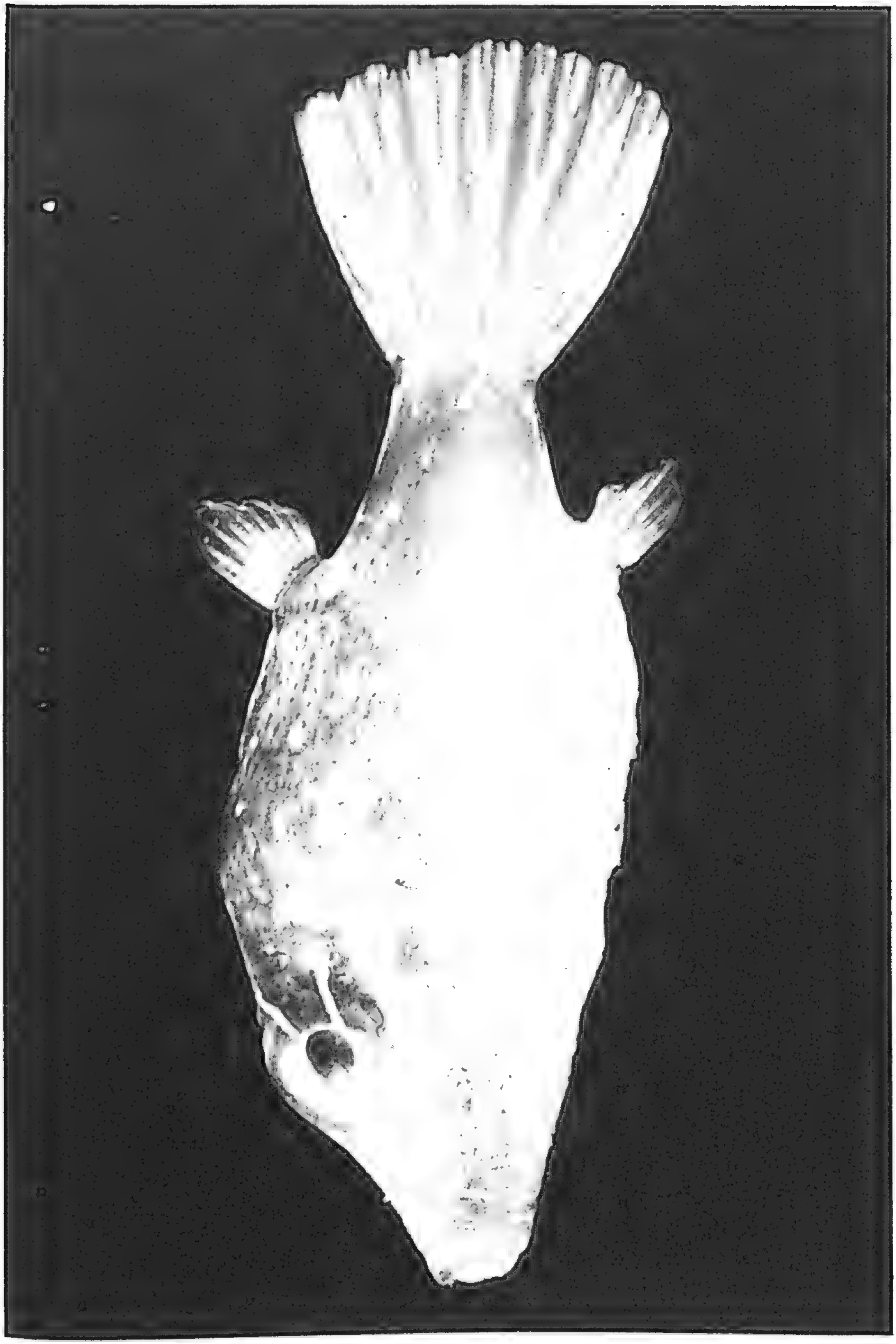

Fig. 15. *Canthigaster pygmaea*, holotype, 30 mm SL, Gulf of Aqaba, Red Sea.

TWO CHONDRITES FROM NEW SOUTH WALES

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SUMMARY

The Rowena olivine bronzite chondrite (H6) was broken into many fragments when struck by a plough on "Franxton" property (lat. 29°48', long. 148°38'), 27 km west of Rowena railway station. It was found in January 1962. The stone was weathered and the weight of fragments recovered was 34.42 kg. The mineral composition and structure are given.

The Willaroy bronzite chondrite (H3) was found lying on the ground on "Willaroy" property (lat. 30°06', long. 143°12') on 12 March 1970. It was in four pieces the total weight being 4.05 kg. It was weathered. Mineralogical compositions and a chemical analysis are given.

ROWENA

INTRODUCTION

"Franxton" property is owned by Mr. Henry Morse. It is situated on the black soil flood plain of the Barwon River in northern New South Wales, about 500 km north-north-west of Sydney. The site of the discovery is on lat. 29°48', long. 148°38', 27 km west of Rowena railway station.

Some time in January 1962 Mr. C. M. Phelps of Glen Eden, Rowena, and his brother-in-law Mr. R. Colyvan of Narrabri were ploughing in a paddock on "Franxton" This stony meteorite was struck by the plough and 34.42 kg of fragments were recovered, the two largest weighing 14.8 and 9.2 kg respectively. The remainder of the fragments ranged down to quite small pieces.

Mr. Colyvan sent all the fragments to the Mining and Geological Museum in Sydney and they were later sent to the Australian Museum by Mr. H. F. Whitworth, then Curator of the Mining Museum. Mr. Ray Witchard, of the Preparation Section of The Australian Museum faithfully joined the fragments together. Views of this are shown in figures 1 and 2, with the original surface outlined in chalk. No original surface is present on the back of the reconstruction indicating a greater original unweathered mass. The original mass of the Rowena would therefore have been one of the largest of Australian stony meteorites, exceeded in weight in all probability, only by the Barratta stones Nos. 1 and 5, and Karoonda.

Records of The Australian Museum, 1977, **Vol. 30, No. 18,** 519-531, Figures 1-12.

The prevailing colour of the remaining original surface is light brown. An extensive surface on one fragment is deep reddish brown. Small black patches are occasionally present. Many cracks due to weathering are present on the original surface. Weathering is so pronounced that it masks any original fusion crust and makes a chemical analysis futile. It is not a recent fall.

Thumb-marks are a notable feature. One is particularly deep and can be seen on the bottom edge of the centre fragment in figure 2.

On a cut smooth surface of a separate fragment the following features are visible: a. numerous open veins lined with limonite; b. fragments of nickel-iron relatively abundant and fairly evenly scattered through the stony matrix; c. occasional metallic fragments of bronze colour, presumably troilite; d. a patch of a greenish yellow mineral presumably reevesite.

MINERALOGICAL COMPOSITION AND STRUCTURE

A thin section of this meteorite shows a granular aggregate of olivine and pyroxene, with interstitial opaque material, largely nickel-iron and troilite; weathering has converted much of the nickel-iron to limonite, which has stained the silicate minerals brown and extends as microscopic veinlets throughout the meteorite. A little reevesite was observed in the limonite veinlets. Chondritic structure is not prominent; the few chondrules in the section, averaging 1-2 mm in diameter, merge almost imperceptibly with the matrix. The commonest type of chondrule shows alternate thin lamellae of olivine and pyroxene. The matrix has an allotriomorphic-granular texture; olivine grains range up to 0.5 mm in diameter, while the pyroxene grains are generally smaller. Microprobe analyses show that the olivine and pyroxene are essentially uniform in composition, the olivine averaging 19.5% Fa, the pyroxene 17.6% Fs; the pyroxene contains 0.6% CaO. A few small grains of plagioclase, some of them polysynthetically twinned, were observed. Ramdohr (1966) has studied the opaque minerals in this meteorite, and records kamacite, native copper, troilite, chromite, pentlandite, chalcopyrrhotite, and valleriite (the latter mineral is probably mackinawite). The finely-granular nature of the matrix and the partial obliteration of the chondrules suggest a shock episode in the meteorite's history; the network of limonite veinlets may follow fractures produced by shock.

The composition of the olivine and pyroxene shows that Rowena belongs to the olivine-bronzite chondrites (H group); the texture and the presence of plagioclase place it as H6 in the classification of Van Schmus and Wood (1967).

WILLAROY

INTRODUCTION

Willaroy is a property in the Western Division of New South Wales. It is situated approximately 88.5 km by road, north-north-east of the opal mining town of White Cliffs.

The country is low lying, sparsely vegetated and characterized by red sandy soil. It is a semi-arid region. The annual average rainfall approximates 220 mm.

On 12 March, 1970, Mr. L. S. Brown, owner of "Willaroy" found four fragments of a stony meteorite lying close together on bare ground. The site is about 4 km north (lat. 30°06′, long. 143°12′) of the homestead and 0.8 km south-west of an earth dam known as Red Tank.

GENERAL DESCRIPTION

Mr. Brown brought one of the fragments into the Australian Museum where it was identified as a chondrite. In July 1970, R. O. Chalmers accompanied by Mr. H. O. Fletcher, visited Mr. Brown and were taken to the site where he had left the three remaining fragments as he had found them (Fig. 3). A thorough search over several kilometres surrounding the site, on foot and with good visibility through sparse vegetation yielded no other masses.

The four fragments were subsequently found to fit together to form a single mass. Their close mutual proximity when found suggests that the original single mass broke into four pieces on hitting the ground or, subsequent to the fall, weathering along planes of weakness may have caused separation. The total weights of the four fragments is 4.05 kg. The largest fragment weighs 2.54 kg.

The colour of the Willaroy is reddish-brown. Remnants of the fusion crust were visible, but the characteristic lustrous fused appearance observed in meteorites that had fallen recently had been dulled by weathering over a long period. The rest of the crust had lifted and flaked off. In places layers of small quartz fragments cemented by iron compounds adhered firmly to the surface.

Chondrules were clearly visible, standing out in relief on the broken weathered surface of the fragments. Nowhere could the fresh appearance of the unaltered meteorite be observed. It is apparent that it is not a recent fall. A surface from which a slice was cut for sectioning is dark grey, almost black, with numerous lighter grey chondrules showing prominently. Minute particles of nickel-iron are sparsely distributed within the meteorite. The specific gravity is 3.54.

The shape of the Willaroy is roughly pyramidal. The base has four main edges and is smooth. Rising from the base, four main relatively smooth surfaces meet forming a blunt cone. The blunt cone can be seen on the top right-hand corner of the specimen (figure 4). Conical shaped meteorites are considered to be oriented (Mason 1962, p. 39), so that Willaroy belongs to this type. The fragments, fitted together, show the shape of the complete mass (figure 4). This illustration also shows portion of the base and two of the roughly triangular main surfaces. There are three other main surfaces on the back of the specimen. One of these, roughly four-sided, is the largest of all and measures 16 × 10 × 4.5 × 1.9 cm. Two of the three back surfaces meet the two triangular faces shown in figure 3 to form the blunt cone. At the back of the specimen two smaller curved surfaces join the edge of the base to the largest surface. These are the only faces to show regmaglypts (thumb-marks), three in all. All are shallow. The largest and best developed one measures 3 × 4 cm.

MINERALOGICAL COMPOSITION AND STRUCTURE

A thin section of the meteorite (figure 5) shows a close-packed aggregate of chondrules, 0.5-2 mm in diameter, with a small amount of angular mineral fragments, in a black opaque matrix. Brown limonitic veinlets, the result of terrestrial weathering, cut through the body of the meteorite. A wide variety of chondrules can be distinguished, some of which are illustrated in figures 5-12. Most chondrules consist dominantly of olivine crystals with interstitial glass, which is sometimes transparent and pale brown, but is more often turbid and dark grey because of partial devitrification. Some chondrules contain both olivine and clinobronzite, the latter usually as subhedral prismatic crystals showing the characteristic thin polysynthetic twin lamellae. A few chondrules are extremely fine-grained, almost cryptocrystalline, and probably represent devitrified glass; microprobe analyses show that these vary somewhat in composition from point to point, but are dominantly of pyroxene.

An X-ray diffractometer trace shows fairly sharp olivine peaks, indicating an average composition of Fa_{13} according to the technique of Yoder and Sahama (1957); the peaks are somewhat asymmetric and are skewed towards higher Fa values. The pyroxene peaks correspond to clinobronzite, although a minor amount of orthopyroxene could be present but undetected. The pyroxene peaks are rather broad, suggesting variable composition. These X-ray results have been confirmed by microprobe analyses. Olivine compositions range from Fa_{10} to Fa_{19}, with a mean of $Fa_{14.6}$ Pyroxene compositions range from Fs_6 to Fs_{30}, with a mean of $Fs_{14.5}$ the calcium content is also variable, ranging from 0.2% to 4.6% CaO.

Accessory minerals include nickel-iron, troilite, pentlandite, chromite, spinel, and tridymite; no feldspar was seen. Microprobe analyses show that the metal is uniformly of low nickel content, ranging from 3.0% to 6.4% Ni, with an average of 4.4%. Troilite contains less than 1% nickel. Pentlandite shows a variable nickel content, ranging up to 25.6% but averaging 10.0%; some of the variability in nickel content may be due to the redistribution of nickel during weathering. Chromite occurs as small grains with composition close to $FeCr_2O_4$; a minor amount of aluminium (3.3% Al_2O_3) was determined with the microprobe. A little spinel with composition approximately halfway between $MgAl_2O_4$ and $FeAl_2O_4$ was found with the microprobe. A mineral with composition close to pure SiO_2 was found in the interstitial glass of a pyroxene chondrule; its lath-like form suggests tridymite rather than quartz or cristobalite.

The limonite veinlets resulting from weathering are narrow (usually less than 0.1 mm across), and consist of red-brown goethite with some areas of bright yellow highly birefringent reevesite.

A thin slice was cut from the meteorite and analysed by Mr. E. Jarosewich of the Smithsonian Institution according to established procedures (Table 1). Because of the weathered state of the meteorite, iron was determined as total iron, from which was subtracted iron determined as metal and iron equivalent to S as FeS; the remaining iron was divided between FeO and Fe_2O_3 by calculating FeO from the mean composition of olivine and pyroxene determined by the microprobe. If the Fe_2O_3 in the analysis is recalculated as metallic Fe and the analysis recalculated to 100 after eliminating terrestrial oxygen and water, the nickel-iron content is 18.5 percent and the total Fe 28.2 percent, figures typical of bronzite (H group) chondrites. The calculated normative composition corresponds closely to the actual mineralogical composition, except that plagioclase was not observed in the meteorite, this mineral being represented by the glass in the chondrules. The highly chondritic nature of the meteorite, the variability of olivine and pyroxene composition and the presence of transparent glass in the chondrules indicate that it is an H3 chrondrite according to the classification of Van Schmus and Wood (1967).

ACKNOWLEDGEMENTS

Thanks are due to Mr. L. S. Brown for his care in leaving three of the four pieces *in situ* until they could be examined, for having presented the meteorite to the Australian Museum and for his hospitality to Messrs Chalmers and Fletcher when they visited "Reola" the property on which Mr. Brown resides and which is near "Willaroy".

Mr. Brown's powers of observation are worthy of note. He is the finder of three meteorites. On 21 March, 1944, when as a young man he was mustering on his father's property "Nardoo", 26 km north-west of Wanaaring, in the Western Division of New South Wales, he found two stony meteorites, Nardoo No. 1 and Nardoo No. 2, lying about 9.5 km apart. These he also presented to the Australian Museum. Incidentally the general locality of the two Nardoo stones is about 109 km north-east of "Willaroy". When Mr. Brown found the Willaroy, although it was much more weathered than the two Nardoo stones, he was quite convinced that it, too, was a stony meteorite.

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Table 1. Chemical and Normative Composition of the Willaroy Meteorite (E. Jarosewich, Analyst).

Chemical Composition		Norm	
Fe	1.35	Olivine	25.3
Ni	1.37	Pyroxene	31.1
Co	0.07	Plagioclase	8.5
FeS	4.63	Troilite	4.6
SiO_2	33.85	Nickel-iron	2.8
TiO_2	0.13	Apatite	0.4
Al_2O_3	2.13	Chromite	0.7
Cr_2O_3	0.48	Ilmenite	0.2
Fe_2O_3	22.50	Limonite	25.9
FeO	6.70	Total	99.5
MnO	0.27	H_2O, C	0.82
MgO	21.02	Total	100.3
CaO	1.61		
Na_2O	0.61		
K_2O	0.12		
P_2O_5	0.19		
H_2O (+)	2.70		
H_2O (−)	0.65		
C	0.17		
Total	100.55		
Total Fe	25.30		

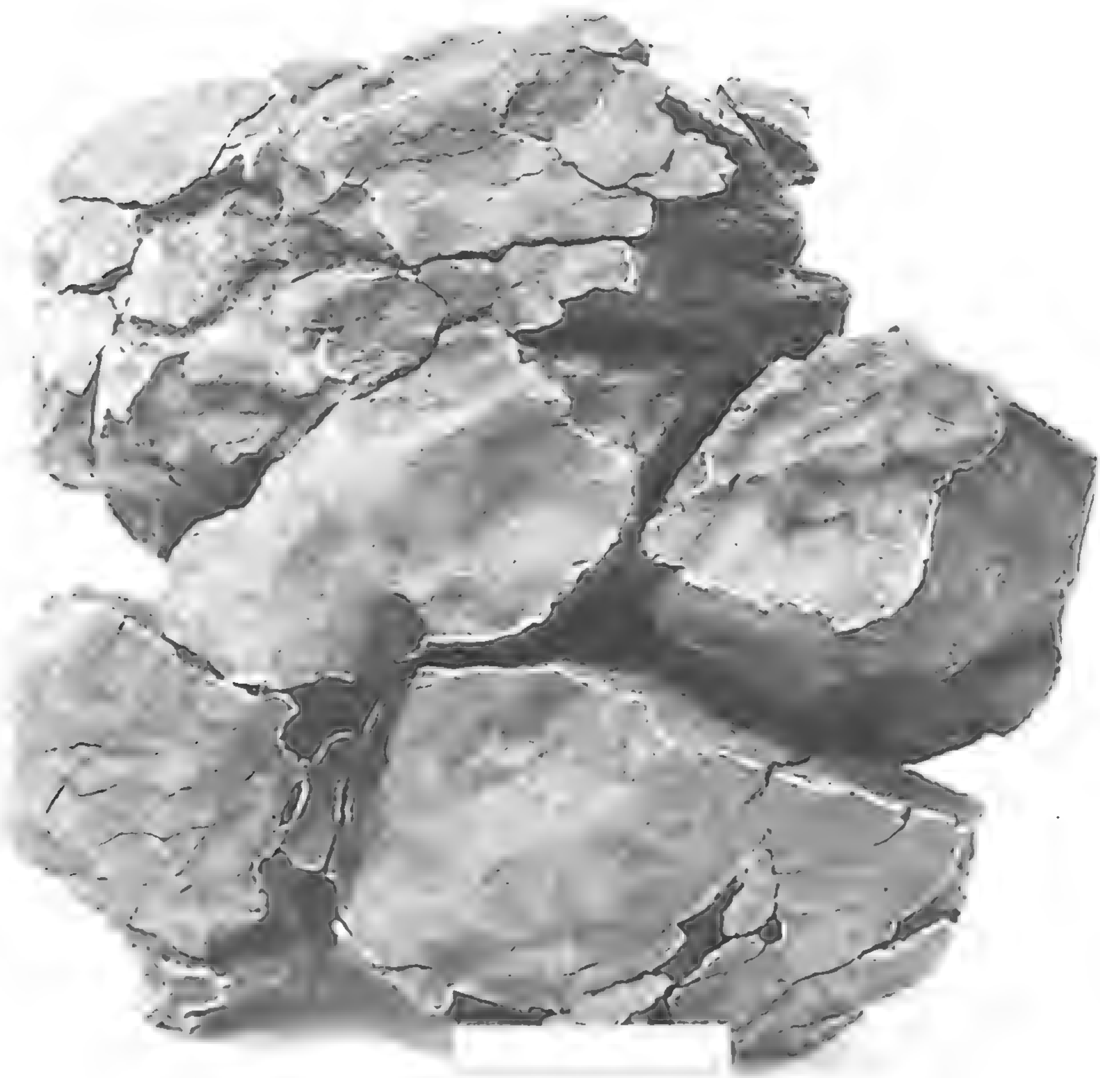

Fig. 1. A view of the reconstruction of the mass of the Rowena chondrite from 34.43 kg of fragments.

Fig. 2. Another view of the reconstruction of the mass of the Rowena chondrite from 34.43 kg of fragments.

Fig. 3. Three fragments of the Willaroy chondrite *in situ*.

Fig. 4. The four fragments of the Willaroy chondrite fitted together.

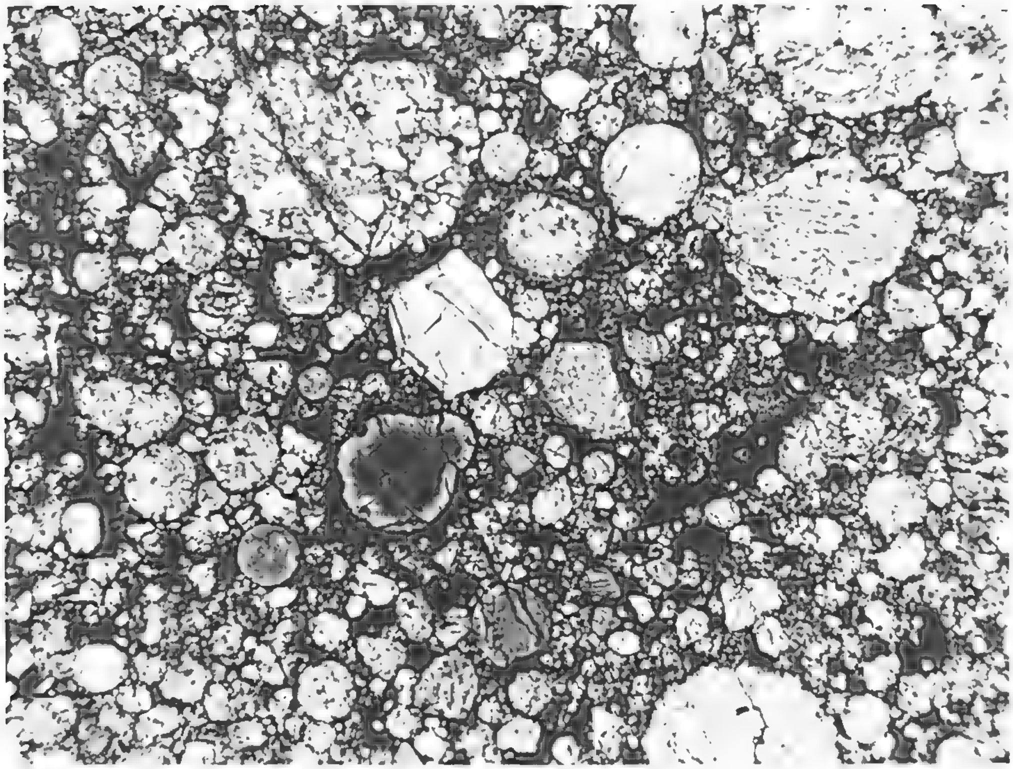

Fig. 5. Thin section, at low magnification, showing closely packed chondrules, 0.5-2 mm diameter, and irregular mineral fragments in a black opaque matrix; the large crystall fragment (1.0 mm across) is olivine.

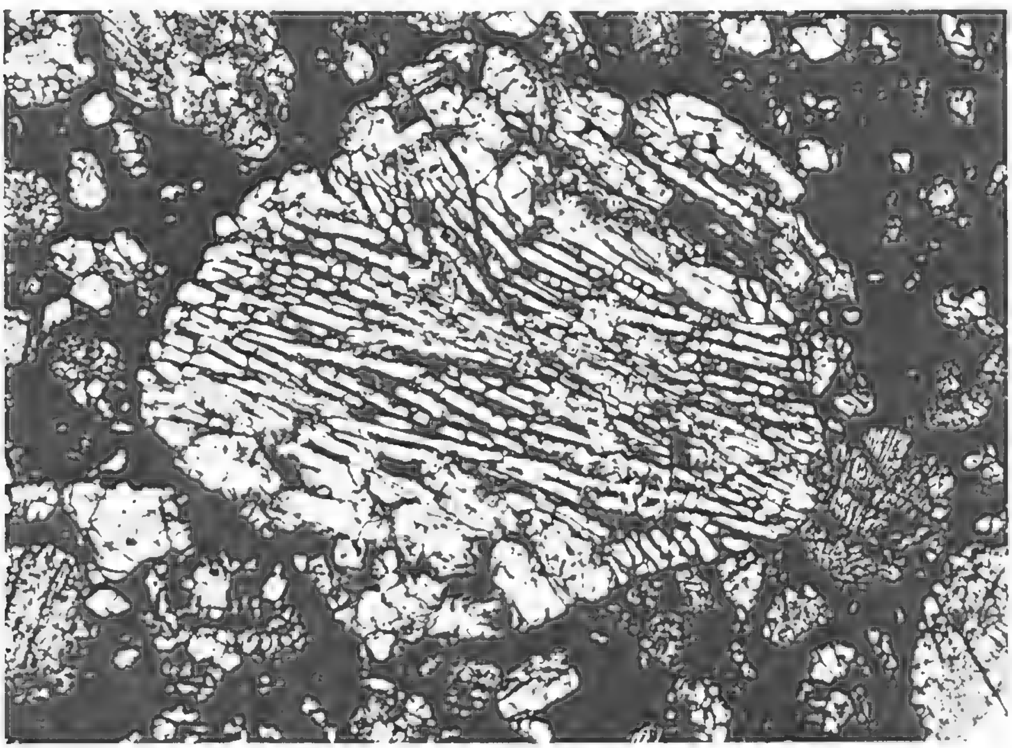

Fig. 6. Barred olivine chondrule with irregular form (maximum dimension 1.5 mm); the dark material between the olivine bars is partly devitrified glass.

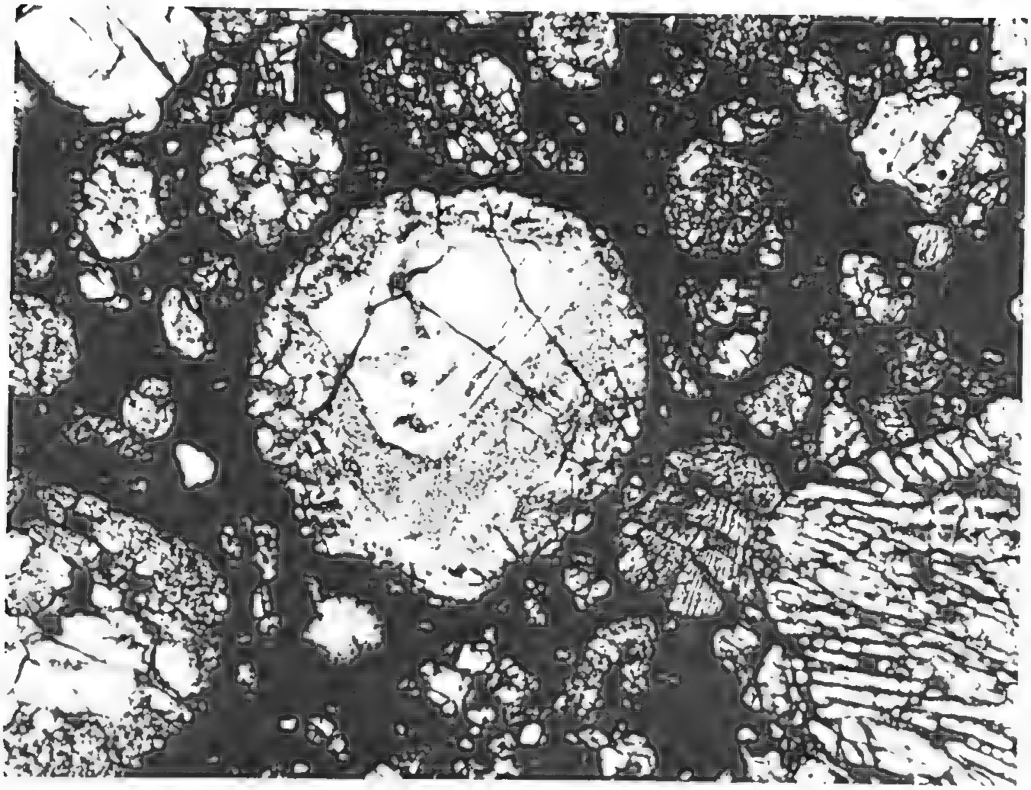

Fig. 7. Chondrule (0.9 mm diameter) consisting of an angular olivine fragment enclosed in a fine-grained groundmass, probably devitrified glass.

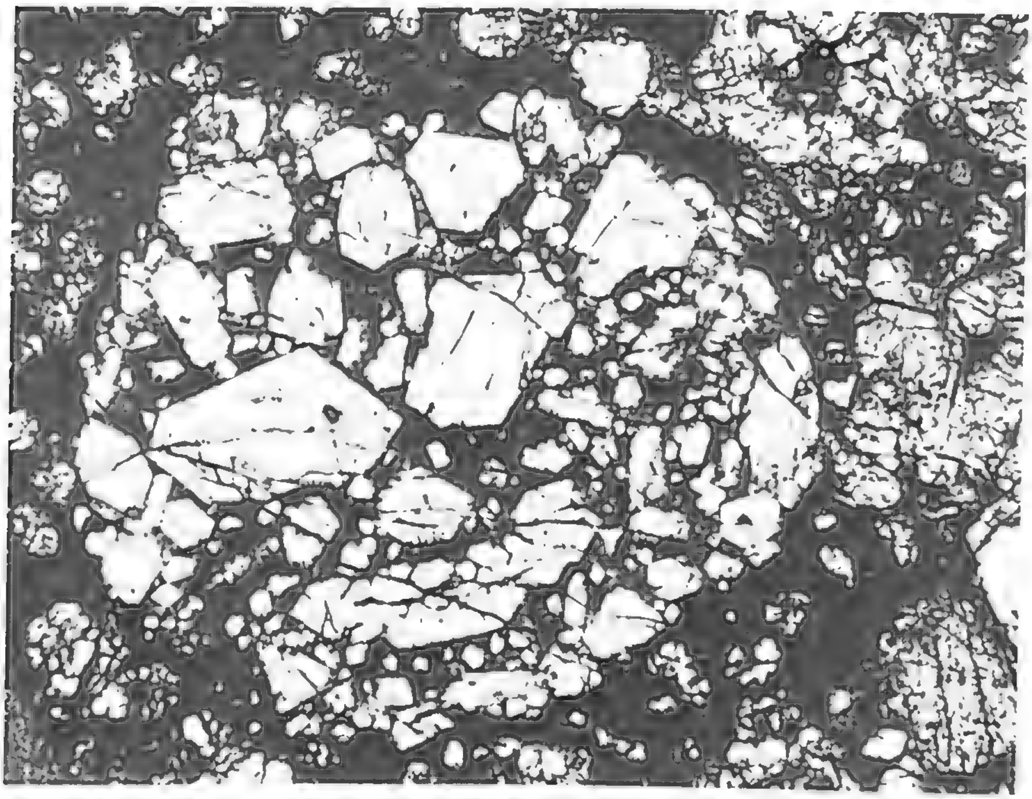

Fig. 8. Porphyritic olivine chondrule (maximum dimension 2.1 mm), with euhedral and subhedral olivine crystals in a dark matrix of partly devitrified glass.

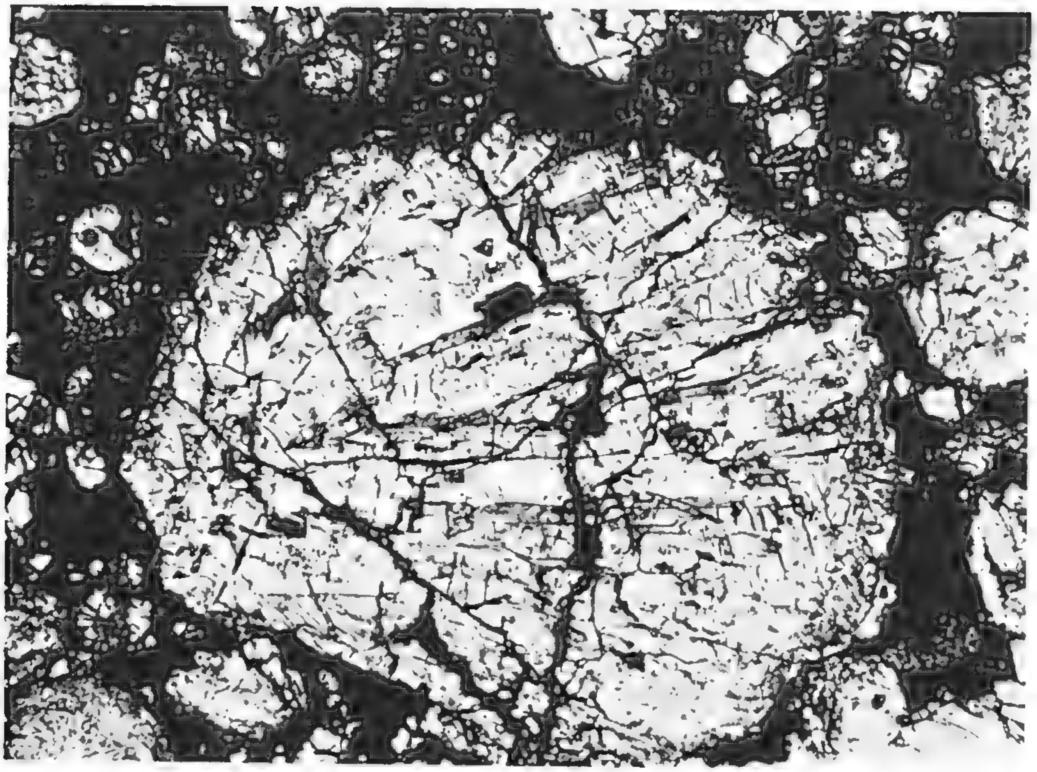

Fig. 9. Radiating pyroxene chondrule (maximum dimension 1.5 mm); a small amount of interstitial pale brown glass is present.

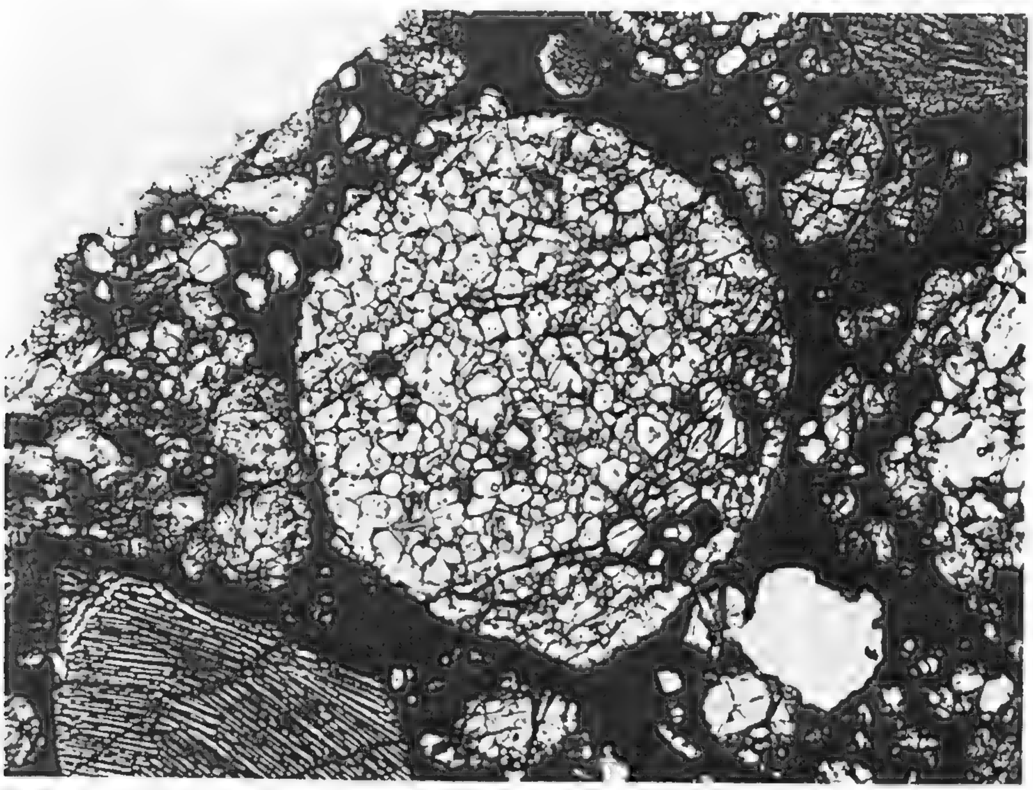

Fig. 10. Granular olivine chondrule (1.0 mm diameter); the material between the grains is pale brown undevitrified glass.

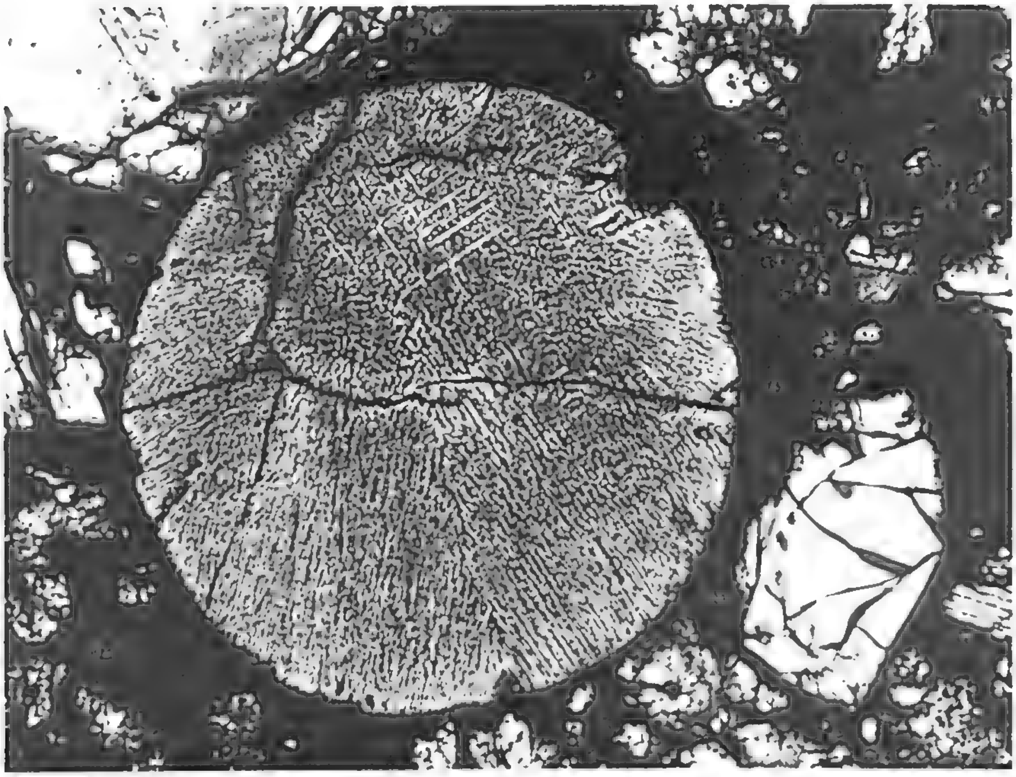

Fig. 11. Chondrule (0.5 mm diameter) of pale brown material, probably devitrified glass; under high magnification the material appears to be finely fibrous pyroxene.

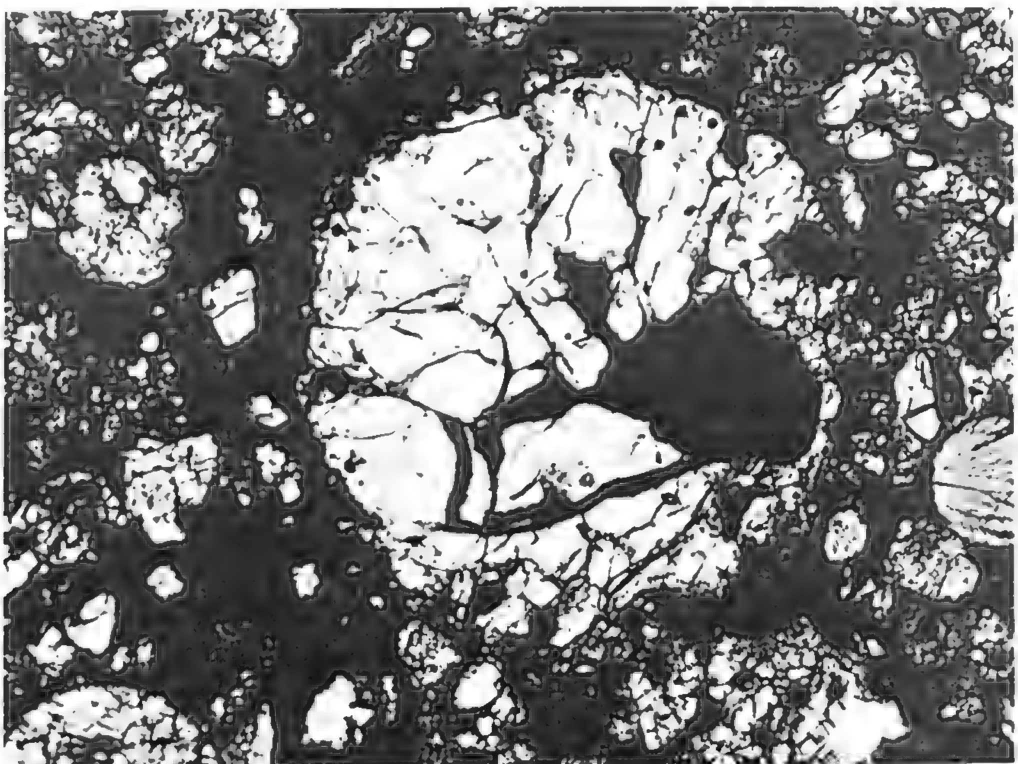

Fig. 12. Chondrule (1.2 mm diameter) of closely packed irregular olivine grains; the opaque material appears to be infiltrated carbonaceous matrix.

CAINOZOIC BASALTS OF THE MT. FOX AREA, NORTH QUEENSLAND

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SUMMARY

The Mt. Fox basalt field encompasses late Tertiary plugs and flow remnants and the Pleistocene Mt. Fox volcano. The flow remnants suggest an earlier largely westerly flowing plateau drainage, captured by southerly flowing drainages which cut through the old valley fills.

The basalts are mostly undersaturated types, basanitic and alkali basaltic rocks, but include transitional olivine tholeiite. Geochemically, the younger Mt. Fox lavas are the most undersaturated and show relative enrichment in alkali and alkaline earth elements.

INTRODUCTION

Cainozoic basalts in north Queensland form a number of provinces ranging up to 7,500 km^2 in area (Twidale, 1956; Branch, 1969; Stephenson and Griffin, 1973). The Mt. Fox field, west of Ingham, is a sparsely scattered province covering about 2,500 km^2 (Figs. 1 and 1a). It flanks the extensive voluminous McBride Province (5,500 km^2) to the north-west. Its westernmost occurrences have been referred to as the Older McBride Province and assigned late Miocene (?) to early Pliocene ages on the association with diatomite deposits (Best, 1959, 1960).

Basalts form older denuded plugs and dissected flows as well as youthful pyroclastics and lavas of the extinct Mt. Fox volcano. These lie on a dissected Tertiary plateau, which slopes gently westwards from about 800 m to 480 m a.s.l. at the Burdekin River, where it skirts the flank of the McBride basalt shield. Study of the flow remnants is important in reconstructions of the old plateau drainage; some basalts appear to trend across the Douglas River valley which has captured much of the present drainage.

Specimens and thin sections of the rocks are held in the collections of The Australian Museum. Analysed rocks are registered from DR9426 to DR9434 and thin sections are registered from AM6716 to AM6744.

Records of The Australian Museum, 1977, Vol. 30, No. 19, 532-543, Figures 1-3.

DENUDED PLUGS

Two small adjacent plugs intrude Silurian-Devonian beds west of Camel Creek Homestead. They probably represent the oldest basalts as they differ petrologically from the surrounding flow remnants. The southern plug contains sporadic lherzolite xenoliths and conspicuous glomeroporphyritic clinopyroxene; it approaches an ankaramitic potassic basanite (Analysis 1, Table 1). The northern plug consists of dense, alkali olivine basalt (Analysis 2). Between them lies a poor exposure of partially fused and fractured banded quartz-labradorite granofels. This appears to represent a metamorphic xenolith, of at least amphibolite facies, brought up by the ascending magma from underlying Precambrian basement, which outcrops 35 km to the north-east.

FLOW REMNANTS

The distribution of the flow remnants and associated sub-basaltic sediments (including stanniferous leads and silicified quartz sands) is summarized in Figs. 1 and 1a. The remnants, individually up to 45 m in thickness, are mostly alkali basalts, but include basanite and transitional olivine tholeiite.

Mildly alkaline olivine basalts (Analyses 3 and 4), closely similar in petrography, extend eastwards from the "Red Hill" area, dropping in elevation to form a pedestal under Mt. Fox (1 in 75 average gradient) and isolated occurrences at Mt. Dora (1 in 250) and The Knobs (1 in 350). Previous workers considered Mt. Fox as the source, but the elevations suggest an eruptive point further east near the edge of the plateau. These remnants outline a westward to south-westward flowing pre-basaltic drainage, assuming no significant post-basaltic tilting. Where basalt overlies silicified sandstones near Kallanda, the bedding is practically horizontal (Shepherd, 1943; Ridgway, 1944, 1947).

Closely similar basalts, associated with silicified quartz sands west and north-west of Camel Creek Homestead are slightly more potassic (Analysis 5). They reach their highest elevation near Lucy Creek and appear to represent lavas which filled and overtopped its tributaries to flow south into the Hopewell and Camel Creek drainages. Their source is unknown, but they may have emanated from the McBride Province near Lake Lucy prior to headward erosion and downcutting of the present Burdekin headwaters.

Petrographically different basalts disconformably overlie the lower flow to cap The Knobs (augite-olivine basalt), extend from near Mt. Fox to west of Camel Creek Homestead (transitional olivine tholeiite) and descend the coastal scarp into the Stone River valley as an erosionally inverted valley fill (lherzolite-bearing basanite). The age of the Stone River basanite relative to the plateau flows is uncertain because of the potentially greater erosion from higher rainfall and steeper gradients on the coastal scarp. The Knobs basalt is mildly alkaline (Analysis 6), but is enriched in groundmass olivine and contains glomeroporphyritic augite. Its source is unknown; similarly textured basalts occur in the McBride Province, but are chemically quite different (T. J. Griffin, pers. comm.). The olivine tholeiite (Analysis 7) is highest near Michael Creek, but it would be unwise to assume that Mt. Fox nearby was the source for such a dissected basalt. It overlies stanniferous deep leads 5 km WSW of Mt. Fox (Morton, 1946) and at Black Cow Creek (de Keyser, *et al*, 1964) and calculated average pre-basaltic gradients give approximate drops eastwards of 1 in 75 (Michael Creek to Mt. Fox lead), 1 in 150 (Mt. Fox lead), 1 in 350 (Mt. Fox lead to Black Cow Creek) and 1 in 750 (Black Cow Creek to Camel Creek Homestead).

The extensive dissection, deep weathering and apparent flow paths across the well established valley of the Douglas River, suggest considerable ages for the plateau flows, comparable to or older than those for mesa and plateau flow remnants found in the McBride Province (isotopically dated at 7-8 m.y.; T. J. Griffin and I. McDougall, pers. comm.).

THE MT. FOX VOLCANICS

The Mt. Fox cone, over 120 m high, has a shallow infilled crater. Crudely bedded coarse pyroclastics are interbedded with minor scoriaceous lava tongues. Scoriaceous bombs, ranging to over a metre across, show tails and surface flow features indicative of rotational flight. Below a small erosional breach on the southern crater rim, a flow extends southwards filling in an old tributary of Four Mile Creek cut down below the older flow remnants (Fig. 1). Over 10 m thick, this flow displaced and laterally twinned the drainage, which has now re-cut through parts of it.

Similar craters in the McBride Province are dated isotopically at approximately 200,000 years, but the Mt. Fox cone may have suffered a more rapid rate of erosion because of higher rainfall; it may be as young as 100,000 years, within an error of at least 50,000 years (T. J. Griffin and P. J. Stephenson, pers. comm.). It is almost certainly older than the youngest McBride Kinrara crater dated around 50-70,000 years (loc. cit.).

The Mt. Fox volcanics are undersaturated glassy basanites. The pyroclastics (Analysis 8) show high water content coupled with relatively low Na_2O and FeO : Fe_2O_3 ratios. They are presumably partly leached and altered from their original composition, which probably matched a potassic basanite. The main lava flow is an even more undersaturated and alkaline poikilitic rock with a glassy base (limburgite) and is high in normative nepheline.

MINERALOGY AND PETROLOGY

Compositions of phenocrystic minerals in the ankaramite plug, west of Camel Creek Homestead were determined by electron micro-probe analysis. Glomeroporphyritic titaniferous clinopyroxene shows oscillatory zoning from a core of diopsidic augite ($Ca_{50}Mg_{38}Fe_{12}$; 7% Al_2O_3, 2.5% TiO_2) to less calcic more magnesian rims with lower Al_2O_3 and TiO_2 ($Ca_{45-47}Mg_{44}Fe_{9-11}$; 5-5.6% Al_2O_3, 1.3-1.6 TiO_2); it encloses some of the phenocrystic olivine ($Mg_{76-77}Ca_{0.5}Fe_{22-23}$). With laths of zoned plagioclase ($Ca_{58}Na_{39}K_3$), these lie in a groundmass of more sodic plagioclase, titaniferous augite, granular iron-titanium oxides and some poikilitic analcime. Nepheline is a groundmass mineral in the Stone River basanite.

The bulk of the olivine basalts grade from finer grained intergranular basalts to coarser sub-ophitic to ophitic rocks with more strongly pleochroic titan-augite, more bladed opaque oxides and greater amounts of late-stage and/or secondary zeolites, carbonate, silica and serpentinic and chloritic mineraloids. The transitional olivine tholeiite is characterised by sporadic phenocrysts of andesine ($\sim An_{42}$, with patchy zoning and corroded interiors) and a darkish brown mesostasis containing bladed iron oxide, crystallites and glass.

Chemically, the older denuded plugs show slightly lower SiO_2 and higher TiO_2 than the basalt flow remnants. The basalt flows are mildly alkaline and their norms contain minor nepheline or hypersthene. Certain classifications (Yoder and Tilley, 1962) would regard some of the rocks with normative hypersthene as tholeiitic, but the author follows the scheme of Poldervaart (1964) which allows for alkali basalts with normative hypersthene, providing that Ab – 2En (hy) – 1.50 Fs (hy) is positive. On this basis, Analyses 2, 4, 5 and 6 are alkali basaltic and Analysis 7 is tholeiitic. This is confirmed by plotting the basalts on an alkalis v silica diagram (Figure 2) in relation to the tholeiitic-alkali basalt boundaries of Macdonald and Katsura (1964) and Irvine and Baragar (1971). The lack of significant petrographic differences between the Ne — and low Hy — normative basalts, the presence of titaniferous clinopyroxene and occurrence of considerable secondary minerals, including silica, also suggest a single group of alkali basalts grading into transitional olivine basalts and hawaiites. The Michael Creek tholeiite with higher SiO_2 and lower K_2O and P_2O_5 and high normative

hypersthene is petrographically quite distinct. It is termed a transitional tholeiite as it plots close to the dividing lines in Figure 3 and no sub-calcic clinopyroxene has been identified in it. The Mt. Fox lavas are more undersaturated and alkaline with much higher normative nepheline and higher MgO, CaO and P_2O_5 than the older lavas.

Few trace element data are published for north Queensland basalts and some results from the Mt. Fox field are given in Table 2. In general, the more undersaturated basanitic rocks tend to show the highest values of Ba, Sr and Rb, with the young Mt. Fox lavas being highest in Ba but less high in Ni and Cu. In comparison, the tholeiitic basalt shows lower values of Rb, Sr, V and Zr, but higher Ga.

DISCUSSION AND SUMMARY

The morphology of the field, apart from the Mt. Fox volcano, suggests eruptions mostly older than the main part of the McBride shield which was built during the last 3 m.y. (isotopic dating, T. J. Griffin and I. McDougall, pers. comm.). Some of the eruptions probably correspond in age with or pre-date the oldest basalts of the McBride Province (7-8 m.y.). This may reflect the apparent westward migration in the focus of volcanism across eastern Australia at a rate of 5 mm/year (Wellman and McDougall, 1974), but it is not clear-cut in north Queensland.

A westerly to south-westerly drainage pattern preserved under the older flow remnants appears to have been disrupted by considerable later headward erosion and capture by southerly drainages. The main lines of longitudinal incision across the basalt fillings developed along Douglas River, Camel Creek and Perry Creek as the Burdekin with its tributary drainage extended northwards. The strongest evidence of old basalt flow lines across the present Douglas River is provided by the very characteristic petrography of the olivine tholeiite which is generally consistent from outcrop to outcrop. The alkali basalts across the Douglas River are also consistent in their petrography, but are a common type of basalt and more difficult to correlate. The divergence of the alkali basalt and tholeiite flows westward across the Douglas seems to reflect overtopping and deflection of the thick tholeiite into a separate tributary drainage.

Reassembly of the flow remnants indicates that some of the lavas travelled at least 40 km and possibly 60 km or more. Long flows exceeded 80 km are known in some north Queensland provinces (Stephenson and Griffin, in press) and are attributed mainly to high continued effusion rates and favourable topography. Some of the flows in the Mt. Fox field match these long flows in chemistry and low average slopes (less than 5°), but in contrast show fluidal and/or more porphyritic textures. This would suggest advanced crystallization at distances under 80 km, in keeping with relatively sparser and presumably less voluminous effusions in the Mt. Fox field.

Some structural control on the eruptive sites in the eastern part of the field may be exercised by a strong WNW-ESE trending line downfaulting Carboniferous (?) volcanics against Precambrian (?) metamorphics and passing through the suspected source areas for the "Red Hill" and Stone River lavas. The restricted young activity at Mt. Fox may have picked out a particularly favourable weakness where this line would intersect NNW-SSE fault lines.

Undersaturated and mildly alkaline lavas dominate the field, but it includes tholeiitic lava, a relatively rare feature of the post-Oligocene provinces in north Queensland. The adjacent McBride and Nulla Provinces include some transitional basalts with low-normative hypersthene (P. J. Stephenson, pers. comm.), but not high-normative hypersthene basalts of the Michael Creek type. $Sr^{87} : Sr^{86}$ ratios for the Michael Creek tholeiite fall within the range of alkali basalts of the Nulla Province (0.7041-0.7046; A. W. Webb, pers. comm.) suggesting

that no significant crustal contamination was involved in its generation. The more undersaturated and alkaline Mt. Fox lavas are in keeping with an isolated burst of activity tapping a deep source, well after the main activity had ceased.

Compared with the limited trace element data available for other Queensland provinces, the Mt. Fox field contains higher Sr, Ni, Cr and Cu than found in the alkali basalts of the Main Range and Lamington Volcanics (Stephens, *et al*, 1973), but generally lower Ba, Sr and Rb than found in the alkali basalts interbedded with tholeiitic basalts in the Peak Range area (Mollan, 1965). Detailed investigations in the adjacent McBride, Nulla and Walleroo Provinces by T. J. Griffin and P. J. Stephenson will provide geochemical data for comparisons between sparse and voluminous basalt provinces in north Queensland.

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TABLE 1. MAJOR ELEMENT ANALYSES AND C.I.P.W. NORMS OF THE MT. FOX FIELD VOLCANIC ROCKS

1. Ankaramite (basanitoid). Southern plug, 8 km W of Camel Creek Homestead, Einasleigh Sheet (lat. 145°23.6′E, long. 18°50.8′S). DR9426.
2. Alkali olivine basalt (transitional hawaiite). Northern plug, 8 km W of Camel Creek Homestead, Einasleigh Sheet (145°23.5′E, 18°50.7′S). DR9427.
3. Alkali olivine basalt (transitional hawaiite). West side, below base of Mt. Fox, Ingham Sheet (145°48.0′E, 18°50.4′S). DR9428.
4. Alkali olivine basalt (transitional hawaiite). Mt. Dora, Ingham Sheet (145°36.5′E, 18°55.7′S). DR9429.
5. Alkali olivine basalt (transitional hawaiite). West side of Basalt Dam, Einasleigh Sheet (145°24.1′E, 18°51.5′S). DR9430.
6. Alkali olivine basalt (transitional hawaiite). Top of northern knob, The Knobs, Clarke River Sheet (145°24.8′E, 19°04.6′S). DR9431.
7. Transitional olivine tholeiite. Michael Creek crossing, Mt. Fox Road, Ingham Sheet (145°47.5′E, 18°49.1′S). DR9432.
8. Basanite. Pyroclastics, north side of Mt. Fox cone. Ingham Sheet (145°48.1′E, 18°50.5′S). DR9433.
9. Basanite (limburgite). Flow, south side near base of Mt. Fox cone. Ingham Sheet (145°48.1′E, 18°50.6′S). DR9434.

Analyst: F. L. Sutherland.

Analyses 1-8 mainly by x-ray fluorescence, with Na_2O by flame photometry and FeO by dissolution with HF in the presence of excess ammonium metavanadate and titration against standardised ceric sulphate. Earth Science Laboratories, Macquarie University. Analysis 9 mainly by Atomic Absorption Spectroscopy, on an HF-Boric Acid dissolution, using natural rock standards, Geochemistry Laboratory, James Cook University, with FeO determined as in Analyses 1-8.

Table 1. Major Element Analyses and C.I.P.W. Norms Mt. Fox Field Volcanic Rocks

Analysis	1	2	3	4	5	6	7	8	9
SiO_2	44.74	46.98	48.30	48.95	49.00	47.96	50.34	44.66	43 6
TiO_2	2.79	2.28	1.84	1.99	1.81	2.08	1.47	1.98	1.61
Al_2O_3	13.19	14.38	14.86	15.05	15.12	14.16	15.27	12.67	13.60
Fe_2O_3	3.23	3.56	2.41	2.89	1.96	2.73	3.85	5.05	3.39
FeO	8.43	8.66	8.19	8.00	8.32	8.38	6.80	5.48	7.28
MnO	0.17	0.19	0.15	0.16	0.16	0.17	0.17	0.18	0.16
MgO	9.97	8.89	8.06	8.41	7.93	9.36	7.94	10.38	10.20
CaO	9.43	8.76	8.90	7.86	8.04	8.74	7.93	10.26	10.87
Na_2O	3.31	3.21	3.69	3.25	3.37	2.86	3.50	2.52	4.30
K_2O	1.97	1.08	1.27	1.22	1.59	1.16	0.74	1.81	2.15
P_2O_5	0.86	0.59	0.52	0.47	0.51	0.49	0.31	0.89	0.99
Loss	1.60	0.84	1.79	1.74	1.37	2.21	2.58	4.70	0.82
Total	99.69	99.42	99.98	99.99	99.18	100.30	100.90	100.58	99.0

CIPW Norm	1	2	3	4	5	6	7	8	9
Or	11.64	6.38	7.50	7.21	9.39	6.85	4.37	10.69	12.70
Ab	14.06	27.15	27.42	27.49	28.50	24.19	29.60	17.27	2.12
Ne	7.55	—	2.05	—	—	—	—	2.19	18.55
An	15.32	21.64	20.24	22.88	21.44	22.38	23.77	17.92	11.46
Di	20.72	14.48	16.62	10.52	12.27	14.33	10.07	21.39	28.81
Hy	—	0.84	—	10.48	2.82	8.02	18.86	—	—
Ol	16.83	17.23	16.17	10.62	15.92	13.28	2.35	13.28	14.23
Mt	4.68	5.16	3.49	4.19	2.84	3.96	5.58	7.32	4.92
Il	5.30	4.33	3.49	3.78	3.44	3.95	2.79	3.76	3.06
Ap	1.99	1.37	1.20	1.09	1.18	1.14	0.72	2.06	2.29
Loss	1.60	0.84	1.79	1.74	1.37	2.21	2.78	4.70	0.82
Total	99.69	99.42	99.97	100.00	99.17	100.31	100.89	100.58	99.0
Plag. An	52.15	44.36	42.47	45.42	42.93	48.05	44.54	50.92	84.38
Oliv. Fo	79.30	75.29	71.94	74.72	70.29	75.36	78.32	92.00	80.27

Table 2. Trace Element Data, Mt. Fox Field Volcanic Rocks

Analysis	1	2	3	7	8	9
Ba	310	148	147	158	455	505
Sr	885	637	643	348	142	992
Rb	30	15	14	11	39	38
Zr	250	173	180	143	151	180
Y	28	30	24	25	25	28
U	<1	1	<1	1	2	1
Th	7	4	2	2	7	5
Pb	11	10	8	8	11	11
Ga	22	21	24	47	20	22
Zn	116	127	102	109	113	112
Cu	82	42	56	46	77	87
Ni	229	112	152	151	242	208
Cr	337	253	286	252	341	281
V	192	197	155	127	194	206
Mn	1272	1296	1175	1107	1328	1349

Analysis numbers correspond with those given in Table 1. Element values are given in parts per million and were determined by X-ray fluorescence, using mass absorption data derived from major element analyses; F. L. Sutherland, analyst. The rocks were powdered using a tungsten carbide mill and were not analysed for Co which is a contaminant in this process.

Figs. 1,1a. Maps showing distribution of lavas in the Mt. Fox field, distinguishing the Mt. Fox cone and flow (black and shaded) and older remnants (stippled), with adjacent plugs (Tp), alkali basalts (Ta), olivine tholeiite (Tt) and basanite (Tb). Sub-basaltic silicified quartz sands and related sediments are shown as enclosed unstippled areas. Approximate elevations on the base of basalts are shown in metres, while elevations of silicified quartz sands are indicated with pluses (from the National Topographic 1 : 100,000 mapping, 1973-1974). Dashed lines and arrows represent the approximate drainage courses of sub-basaltic leads. The edge of the coastal range granite batholith is shown as a barbed line, with fault contacts unbarbed. The basalt boundaries are modified from the Bureau of Mineral Resources 1 : 250,000 Ingham, Einasleigh, Clarke River and Townsville geological sheets and include areas of dark soils and basalt float which may not represent true outcrop.

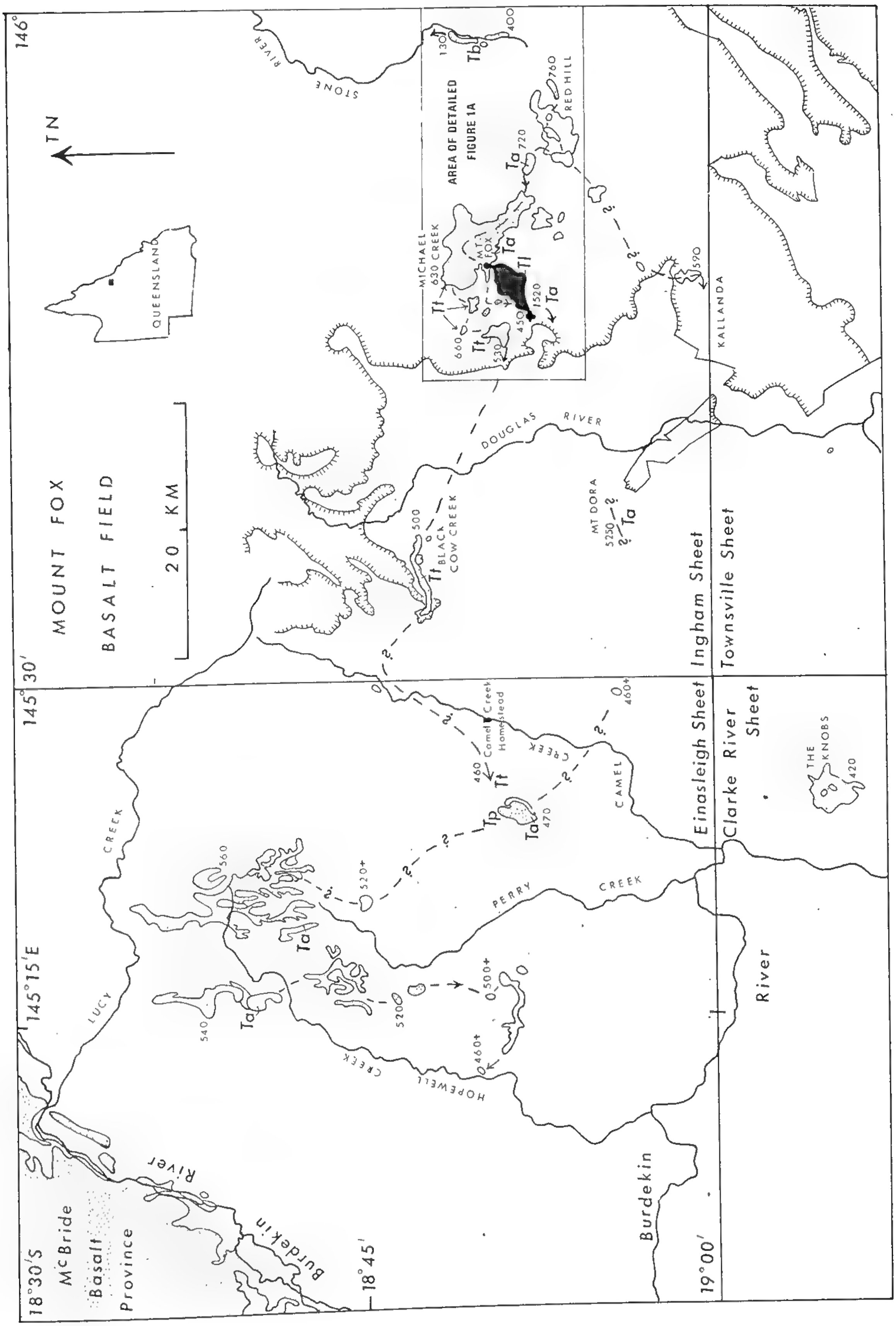
MOUNT FOX
BASALT FIELD
20 KM
TN
QUEENSLAND
146°
145° 30'
145°15'E
18°30'S
18°45'
19°00'
McBride
Basalt
Province
Burdekin
River
Burdekin
River
LUCY
CREEK
HOPEWELL
CREEK
PERRY
CREEK
CAMEL
CREEK
Camel Creek
Homestead
THE
KNOBS
420
Einasleigh Sheet
Clarke River
Sheet
Ingham Sheet
Townsville Sheet
KALLANDA
DOUGLAS
RIVER
STONE
RIVER
BLACK
COW CREEK
MT DORA
5250
MICHAEL
630 CREEK
MT.
FOX
RED HILL
AREA OF DETAILED
FIGURE 1A
Ta
Tt
Tp
Tl
Tb
560
520+
540
520
500+
460+
460
470
460+
500
660
530
450
1520
720
760
590
1300
400

Fig. 1.

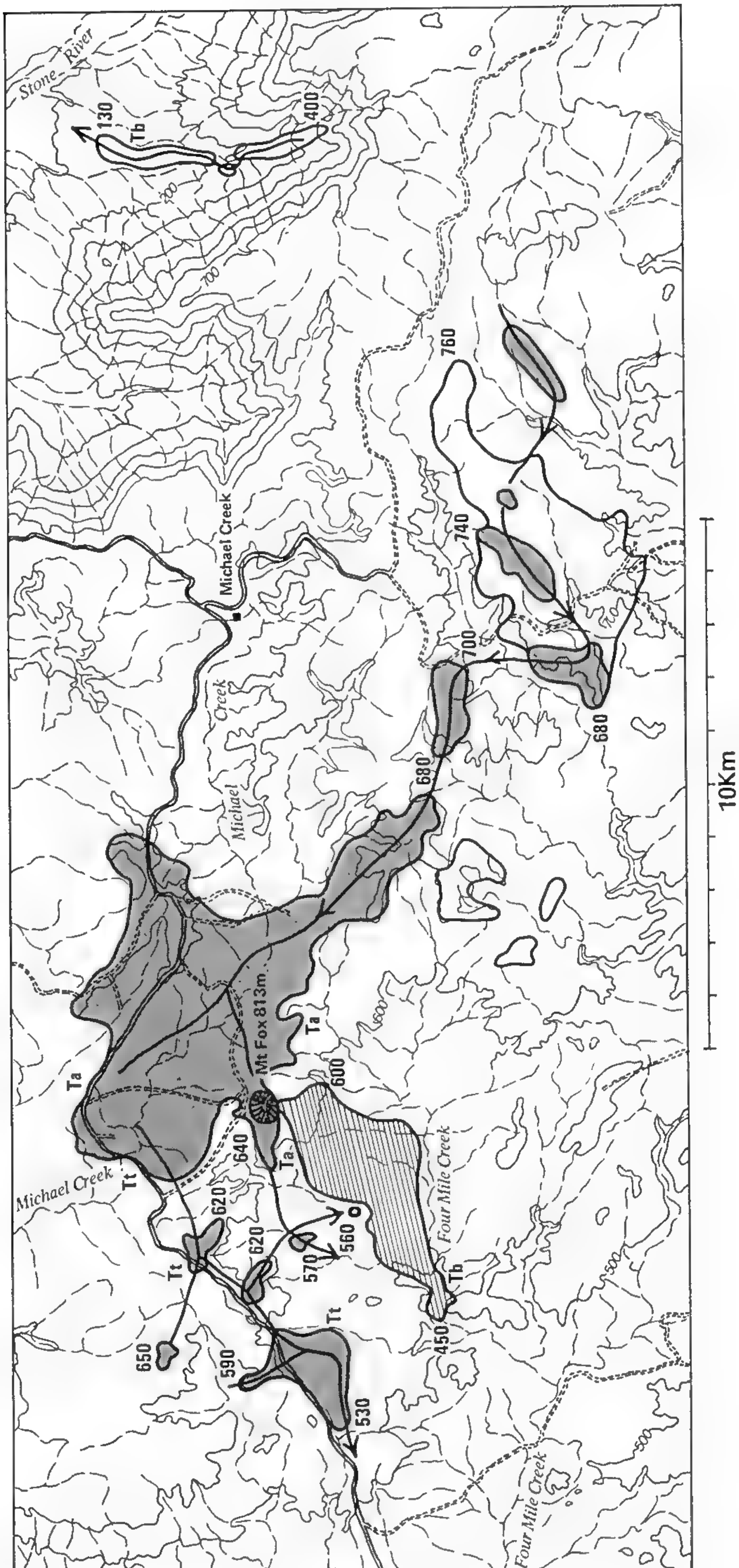
Stone River
130
Tb
400
700
700
Michael Creek
Michael Creek
760
740
700
680
680
Ta
Mt Fox 813m
Ta
600
640
Ta
Michael Creek
Tt
620
620
Tt
570
560
Four Mile Creek
Tb
Tt
450
650
590
530
500
Four Mile Creek
10Km

Fig. 1a.

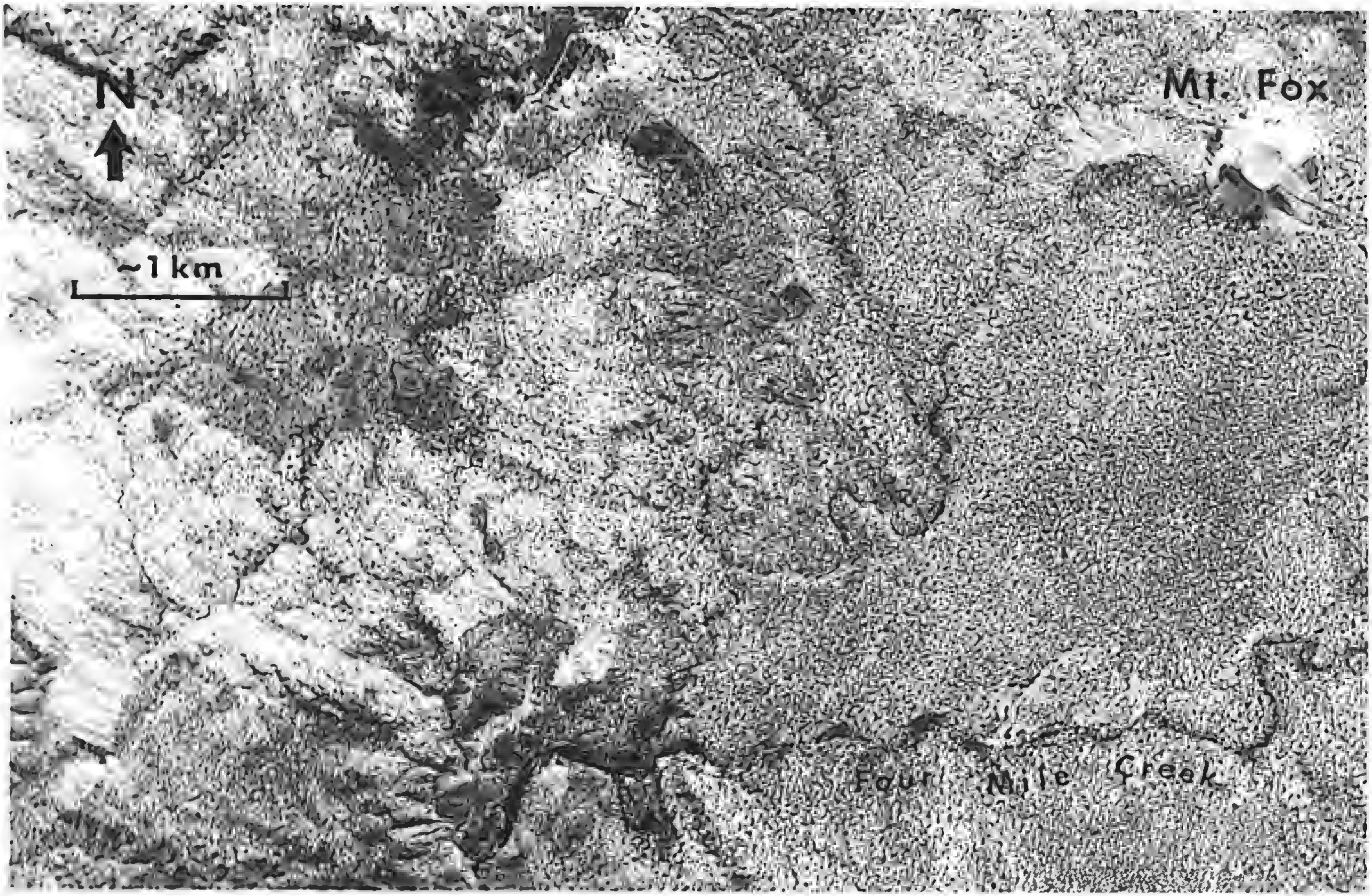

Fig. 3. Aerial view of Mt. Fox cone crater (top right) and an associated flow infilling an old tributary of Four Mile Creek to the south-west. The ridge immediately west (left) of the cone is an older underlying and unrelated flow residual. The enlargement is taken from aerial photograph No. 5060, Ingham Run 8 DWG Series.

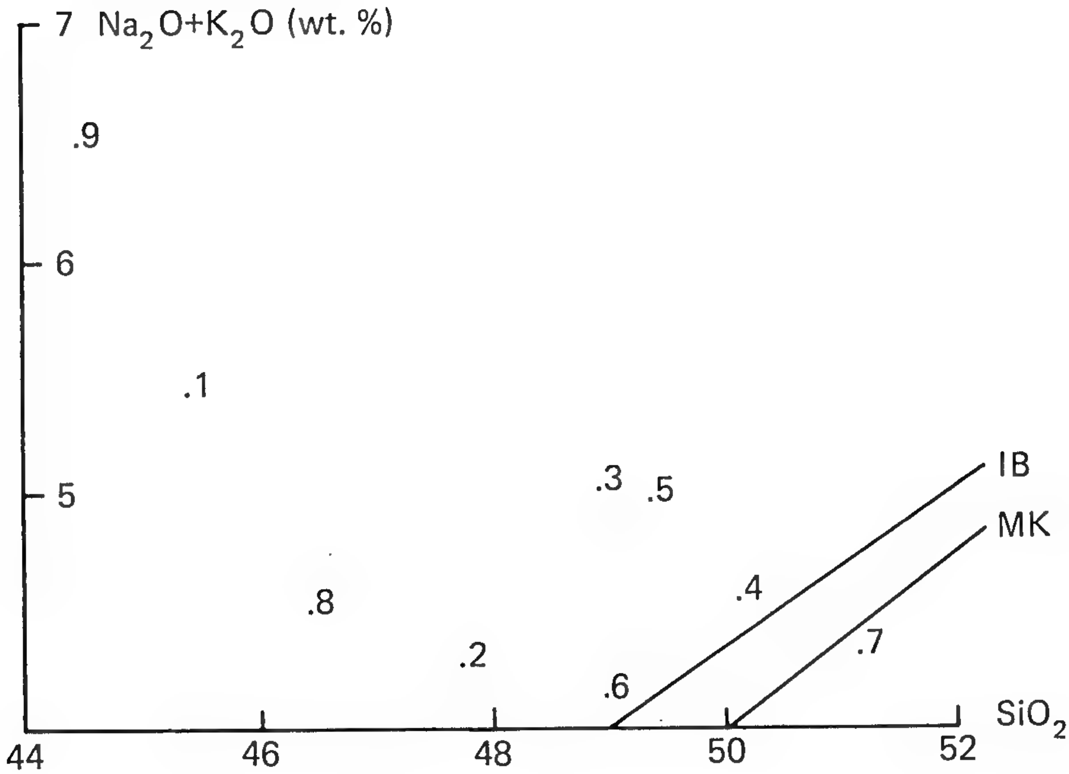

Fig. 2. Silica v. Alkalis diagram showing plots of the volcanic rocks of the Mt. Fox field (Analyses 1-9 recalculated to anhydrous compositions) in relation to the alkali basalt-tholeiite dividing lines of Macdonald and Katsura (1964) and Irvine and Baragar (1971).